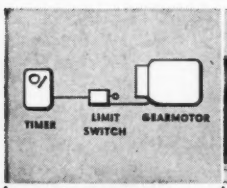
MINING CONGRESS JOURNAL

ANNUAL MINING REVIEW

Automatic Samplers

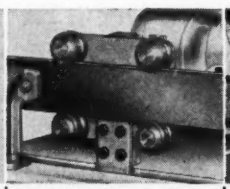
Simple • Low Cost • Accurate • Dependable

Wet, dry, dust tight units, multi-stage sampling, continuous or intermittent operation and complete sampling systems available. Standard units in stock. Heavy duty units to carry special cutters available with cutter travel to 10' and longer. Stainless steel construction available for use on acid circuits. Dimensional drawings and specification sheets are available to assist in preliminary design layouts. Write for Bulletin No. S1-B4.



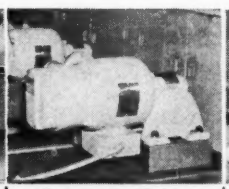
Simple Electric Circuit

Only one limit switch means fewer parts—less trouble. Simplified, easily understood wiring circuit as motor operates in one direction only. Arranged for intermittent or continuous operation.



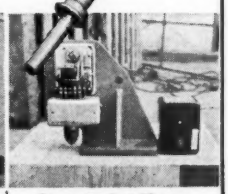
Rigid Track—Rolling Carriage

Cutter is carried on prelubricated, sealed ball-bearing wheels that roll on rigid, cold-rolled steel track. No sliding, metal-to-metal friction. Carriage driven by heavy roller chain with *double carrier pin* to equalize load, avoid twisting.



Gearmotor Drive

Totally enclosed, non-ventilated gearmotor operates in one direction only. Cutter travel limited by magnetic brake. Carriage and chain stop together, start together. Explosion proof motors are available.

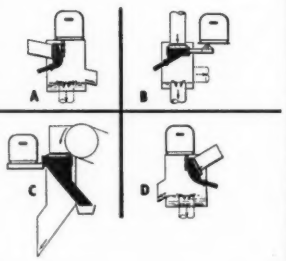


Easy-to-Set Timer

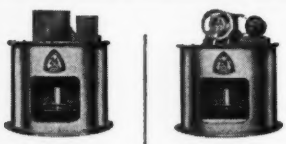
Simple, Telechron driven automatic reset timer. Easy-to-set for intervals from 2 to 55 minutes in 1 minute increments. No gear trains to change, no timing complications like those encountered with reversing motors.

IN STOCK...

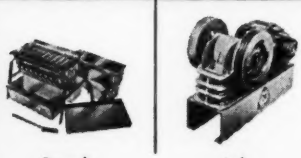
Standard duty 16", 21", 24" and 30" cutter travel units and standard type A, B, C and D cutters.



Complete Line of Samplers and Sample Processing Equipment



Automatic Vezin | Vezin Type Simplex | Vezin Type Duplex | Snyder Type Simplex | Snyder Type Duplex



Sample Splitter | Lab Crusher | Lab Pulverizer | Testing Sieve Shaker, Wet or Dry | Lab Dryer

DECO DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

DENVER EQUIPMENT COMPANY

MINING CONGRESS JOURNAL

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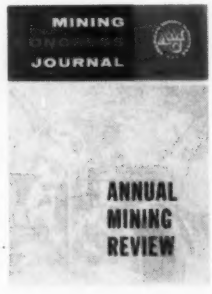
ON OUR COVER

This month's cover speaks for itself. The tinted picture in the background shows an underground hoist on the 4100-ft level at Homestake.

Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $10.00. Single copies, $0.75. February Annual Review Issue, $1.25. Second class postage paid at Washington D. C.



NEW JOY 6-CM

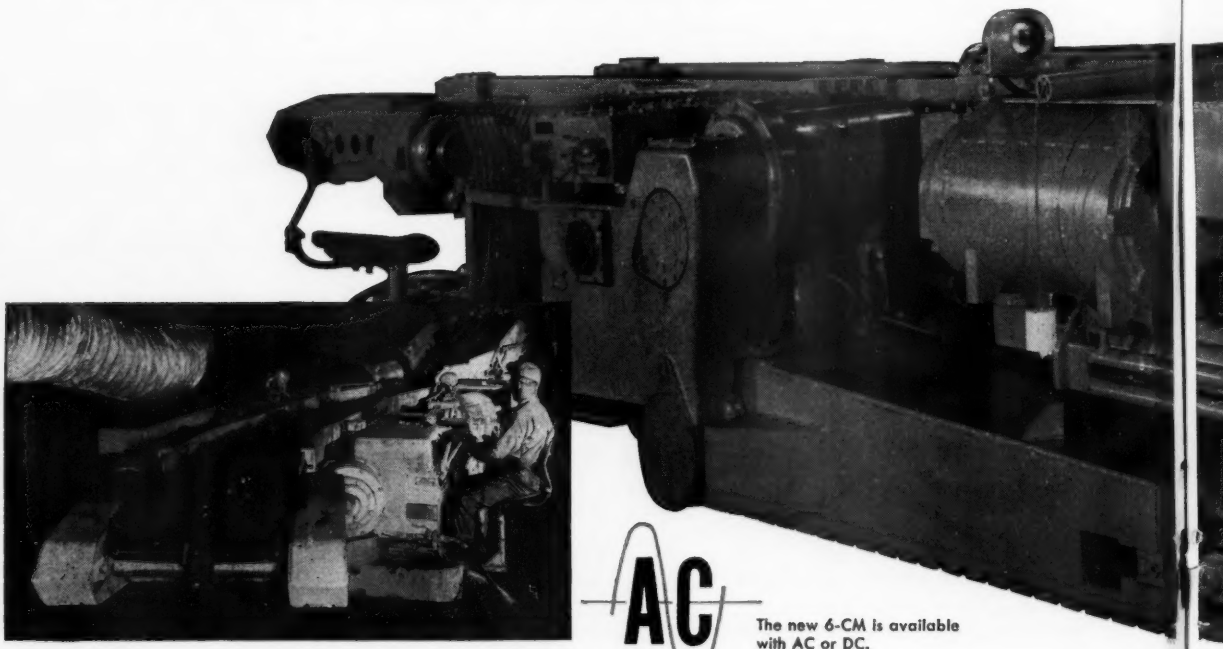
produces 5½ tons per minute
works in coal 5½ to 10 feet

The new Joy 6-CM is an entirely new machine, 48″ high, with every feature engineered into it to accomplish higher tonnage and lower maintenance cost.

The gathering arm clean-up, and the conveyor are each powered independently of the ripper head . . . the Miner can do auxiliary clean-up while the shuttle cars are changing. The coal is stored on the conveyor for immediate unloading.

Extra-wide crawler treads and extra-high ground clearance make the 6-CM sure-footed on the poorest bottom. The crawlers are gear-driven for fast tramming . . . 85 fpm.

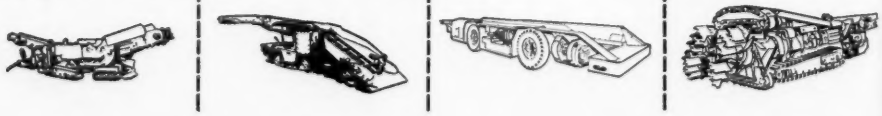
If you are operating a coal seam 65″ and higher talk to a Joy engineer about the 6-CM, the newest continuous miner on the market. **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



AC

The new 6-CM is available with AC or DC.

JOY EQUIPMENT FOR MINING . . . FOR ALL INDUSTRY



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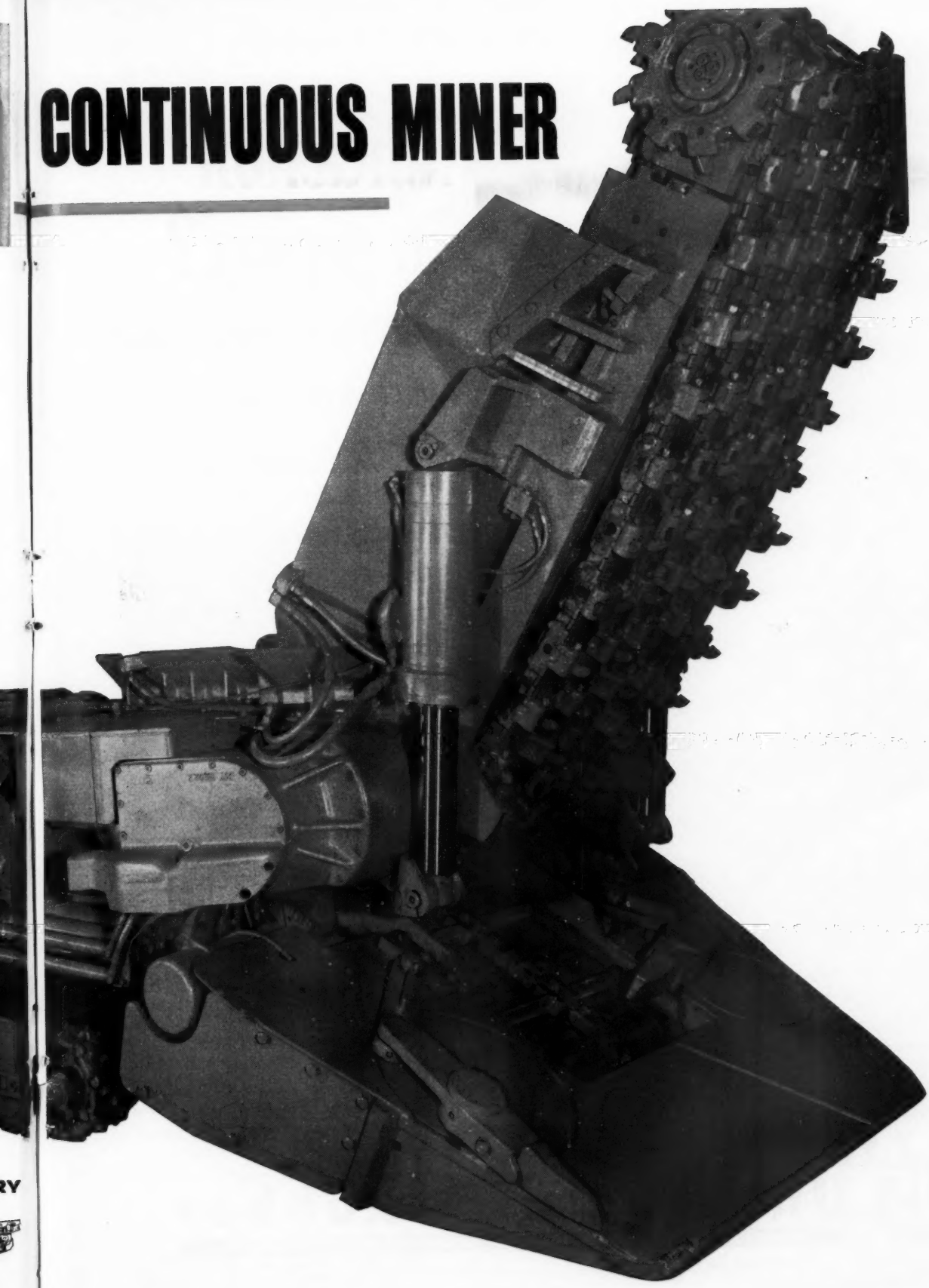
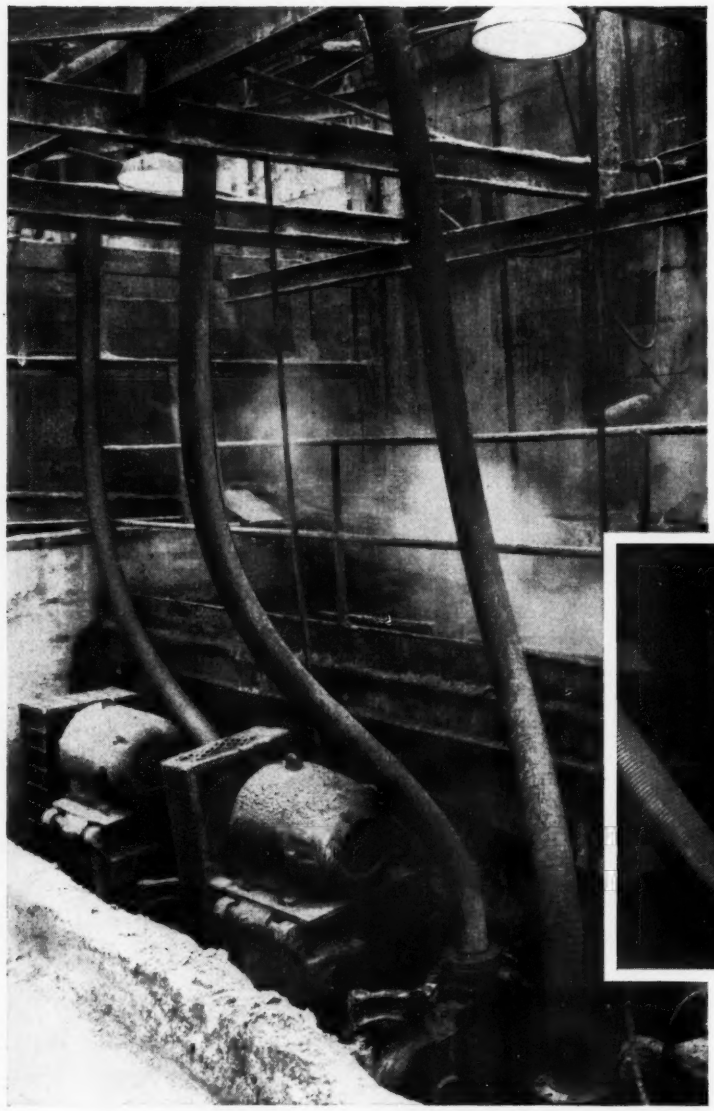
CONTINUOUS MINER



US RUBBER PILOT PIPE



Abrasion in piping?

Here's how a big uranium mill solved it with "U.S." flexible rubber pipe

• Four 8" U. S. Pilot Pipes carry fine screened ore from secondary crusher storage bins. Four more pipes feed too-coarsely crushed aggregate onto a conveyor belt and back into the crusher. On both jobs, Pilot Pipe has lasted over 4 years.

• In this severe service, quenched calcined ore pulp —50% solid—is pumped through these lengths of U. S. Pilot Pipe, from the roaster calcine pumps.

Where to get flexible piping that can stand up to severe abrasion without being chewed up?

Union Carbide's Uravan mill found the answer in U. S. Pilot® Pipe and Pinch Valves. In addition to the operations pictured above, these products handle the slurry on the 9 separate pumping stations of the counter-current decantation wash circuit, are used on the 2 booster stations between leach and tailings disposal plants and between the primary acid leach and roaster.

This pipe is specially built to handle abrasive materials, such as calcined ore, *and corrosive* materials, such as solutions containing sulfuric and hydrochloric acids. It is flexible, easy to install and won't build up. Its service life is longer than that of metal pipe.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber product

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Mechanical Goods Division

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WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

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CATERPILLAR'S PROJECT PAYDIRT

***PROJECT PAYDIRT** pays off for you*

NEW CAT D8 TRACTOR SERIES H

BULLDOZING: PRODUCTION UP... PUSHLOADING: PRODUCTION UP

HORSEPOWER INCREASED 18%—up to 225 from 191 (flywheel).

DRAWBAR HORSEPOWER—up to 180 from 155.

SIZE INCREASED—weight up approximately 4,400 lb. to 47,000 lbs., gauge widened to 84 inches.

LIFETIME-LUBRICATED ROLLERS AND IDLERS—never need further lubrication until rebuilding.

NEW, STRONGER, HEAVIER UNDERCARRIAGE—every component stronger through improved materials and heat treat processes.

SIX DIRECTLY REVERSING SPEEDS—high forward is 6.3 MPH, reverse is 6.4 MPH (direct drive).

DRY-TYPE AIR CLEANER—removes 99.8% of dirt in intake air even under severe operating conditions.

GREATER STABILITY—with 5,505 square inches of track on ground.

BETTER VISIBILITY—new seat placement, location of console-type controls increases operator efficiency.

DEPENDABLE OIL CLUTCH—key retained feature for direct drive; practically eliminates clutch down time.

The new Caterpillar D8 Series H Tractor is ready *now* to increase its lead as undisputed king in its size class. A major achievement of Caterpillar's all-out research program, "Project Paydirt" (see box), the new D8 has been proved by a rigorous field testing program.

This D8 is new in design, appearance and performance. It is bigger, more powerful. It incorporates dramatic new engineering advances. It is easier to operate. And *more economical* to own.

Get the full story from your Caterpillar Dealer. Then *see* this great new machine at work on your job. You can't afford not to!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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BORN IN RESEARCH...
TESTED IN THE FIELD

CATERPILLAR'S PROJECT PAYDIRT

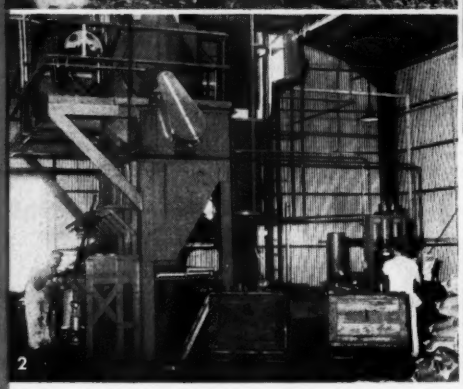
PROJECT PAYDIRT: Caterpillar's multi-million-dollar research program — to meet the coming challenge of the greatest construction era in history with the highest production earthmoving machines ever developed.

CYANAMID

Explosives News

CYANAMID'S NEW CASTLE EXPLOSIVES PLANT INCREASES MANUFACTURING CAPACITY

In construction, mining and quarrying, the increased need for high quality industrial explosives continues to grow. To meet this demand, Cyanamid has recently completed a building and expansion program that includes a new ammonium nitrate plant, as well as many new types of equipment, processes and other facilities. Shown here are a few photographs of the mighty 535-acre New Castle explosive manufacturing operations.



1. One end of the tank battery, the refrigeration plant and storage facilities for glycerine and glycol. Partly hidden by trees (left center) is the gelatin line warehouse and gelatin line dope house.
2. The blasting agents building, where work is being done with an insensitive explosive. To detonate this mixture, a large priming charge of high explosives is required.
3. One of the large wooden chaser-mill type mixers in the dynamite mix house. Here nitroglycerin and nitrocotton are mixed with the "dope" as it comes from the dope house for processing. After mixing, the explosive has been formed. As dynamite, it is taken by tram line to the pack houses.
4. Here packaged explosives are shown on their way by tram to the storage magazine.

Cyanamid customers can be assured of highest quality and unequalled nationwide service now and in the future.

AMERICAN CYANAMID COMPANY

EXPLOSIVES AND MINING CHEMICALS DEPARTMENT

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Photo Number 2 by Jack Simon, New Castle (Pa.) News

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PLANTS:

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High Explosives
Permissibles
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Blasting Agents
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Blasting Caps
Electric Blasting Caps
Blasting Accessories

Cyanidation Process Chemicals
Flotation Reagents
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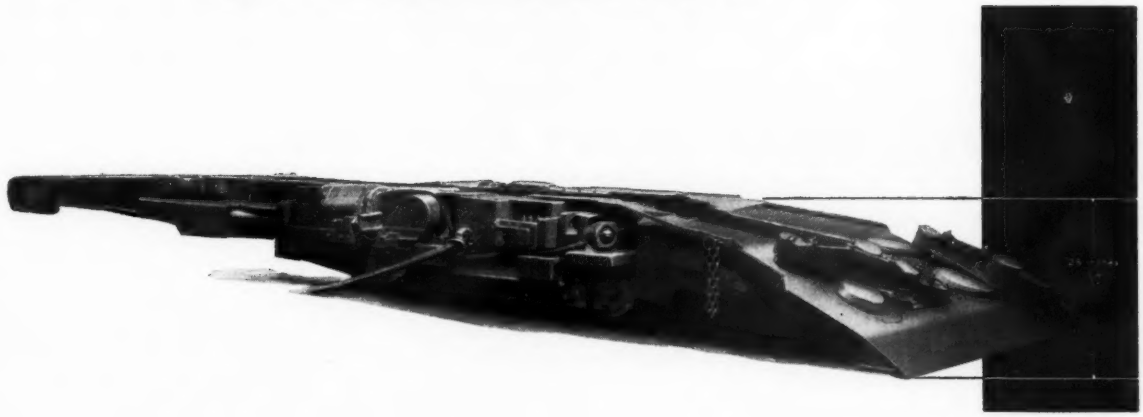
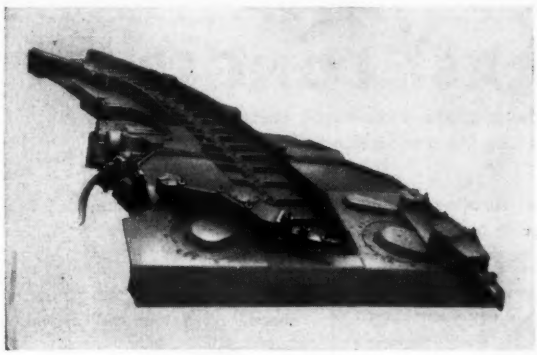
Film Forming Agents
Surface Active Agents

for high capacities
in low seams...
400 tons per shift



JEFFREY 81-C Loaders



Gathering head on Type 81 Jeffrey crawler loaders is fully gear driven; no chain drives between head motors and gathering arms.

Just 25 inches high, this newest Jeffrey crawler loader is ideally suited for low seam work. Offers the same time-tested features that made Jeffrey's 81-A and 81-B loaders so popular . . . fast, easily maneuvered, highly productive.

The Jeffrey 81-C loader is powered by four 15 HP electric motors and a 4 HP hydraulic motor . . . power for the toughest jobs. It has a rated capacity from 6 to 10 tons per minute . . . averaging 400 tons per shift in 33" seams, keeping loading costs to a minimum. Moves fast from place to place, hits loading stride quickly and stays on the job until the work is done.

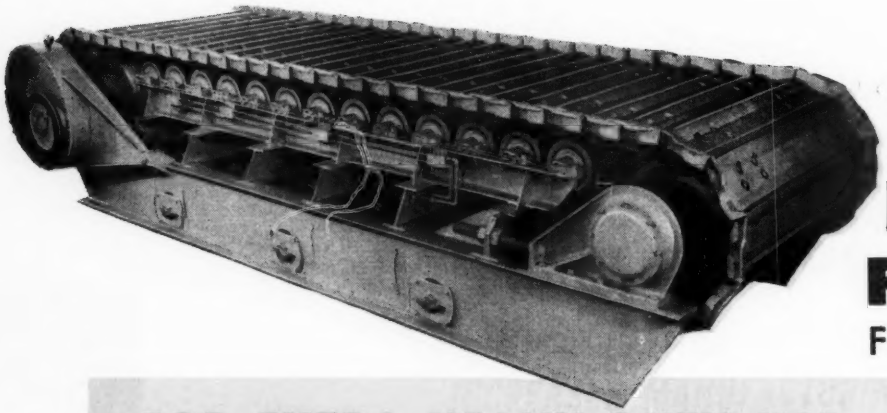
Like all Jeffrey mining machinery, Jeffrey loaders are available for either AC or DC power. With Jeffrey equipment you can make your mine all-AC.

Flexibility built into the Jeffrey loader lets it work most efficiently with other face equipment and the same mining cycle. Conveyor swings 45° either side of center and elevates properly to load shuttle cars on the straight or in break-throughs. Can be turned in its own length.

THE JEFFREY MANUFACTURING COMPANY
958 North Fourth Street, Columbus 16, Ohio

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING



NICO

APRON FEEDERS

FD-4 and FD-8

FOR EXTRA HEAVY DUTY USE

- Uses Mass Produced Standard Crawler Tractor Parts
- Short Pitch, 8" on FD-8, 6-¾" on FD-4, provides more even feed.
- Decks of Cast Manganese or Formed Alloy Steel
- Large Diameter Head and Tail Shafts
- Anti-Friction Self-Aligning Bearings
- Centralized Lubrication Available
- Uses NICO Shaft Mounted Reducer . . .

Eliminates open gearing and lubrication problems

Write for Illustrated Brochures

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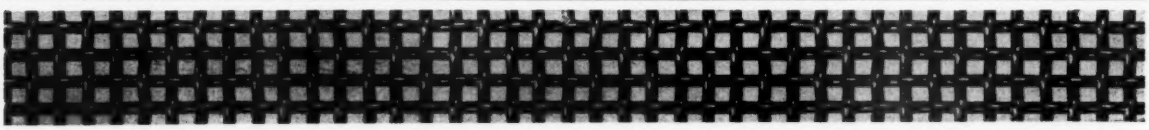
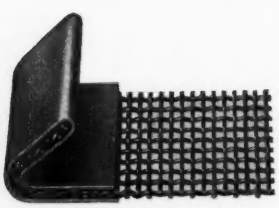
SUBSIDIARY OF PETTIBONE MULLIKEN CORP., CHICAGO 51, ILLINOIS



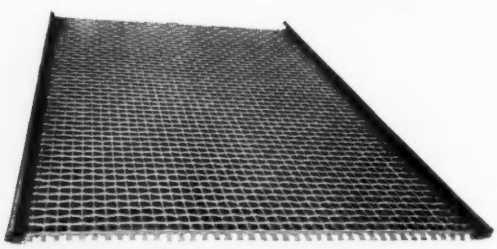
TYLER SCREENS LAST LONGER

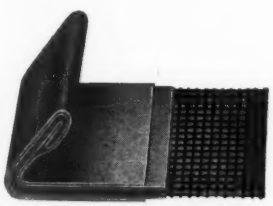
Tyler Woven Wire Screens are woven with laboratory approved wires on precision machines. The high quality of Tyler Screens is apparent in their long life and service under the most difficult of screening conditions.

Tyler Screen Sections are furnished for all makes of vibrating screens in all meshes and metals. Each section is fabricated with the right type of edge or hook strip for the specification of screen cloth and to fit the particular make and model of screening machine on which it will be used.



Tyler Type "AX" Hook Strip. For wire diameters from .047" to 5/16" inclusive.





Tyler Type "CX" Hook Strip. For wire diameters .041" and smaller.

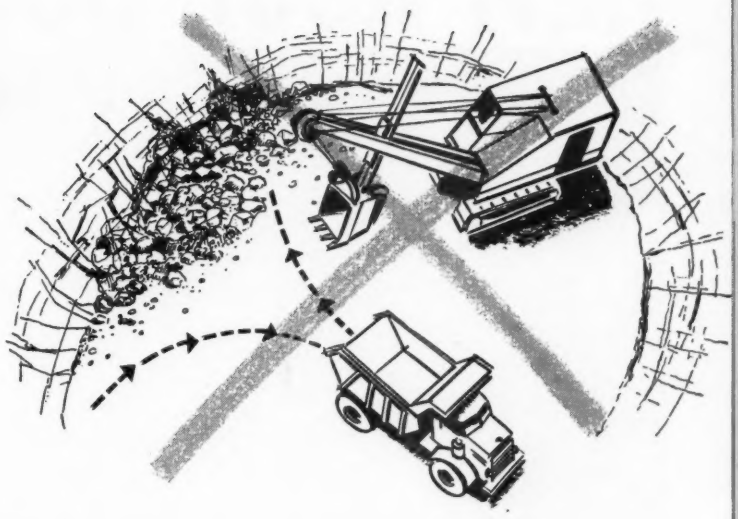
Telephone **HE 1-5400** • *Teletype* **CV 586**

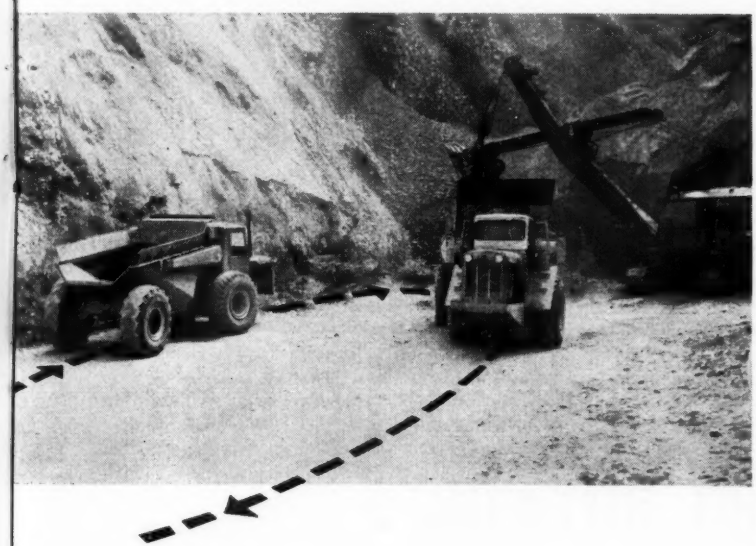
THE W. S. TYLER COMPANY, CLEVELAND 14, OHIO

Manufacturers of Tyler Double Crimped Wire Cloth, Ton-Cap and Ty-Rod High Capacity Screens, Hum-mer Electric Screens, Tyler-Niagara Screens, Ty-Rock and Ty-Rocket Screens, Tyler Standard Screen Scale Sieves, Ro-Top and Ty-Lab Sieve Shakers.

SHORT TURNS
...speed hauling in restricted areas

Even though most haulers make good time on straightaway haul and return, many of them make a poor showing on the entire work cycle. That's because of maneuvering difficulties in restricted load and dump areas. Conventional trucks, for instance — with full-length, 1-piece frame, hydraulic bowl hoist, and automotive-type steer — often slow down production and increase haul costs because of time-wasting maneuvering delays.





Maneuverability is no problem to the pivot-steer LeTourneau-Westinghouse Rear-Dump. Bowl on this off-road L-W hauler is connected to 2-wheel Tournapull® prime-mover by a geared kingpin. Big, instant-acting electric motor swings prime-mover 90° right or left for quick, easy spotting under shovel or at dump. Short-turning L-W hauler makes U-turns in less than its own length, in *only about 70% of length* with bowl raised. Result? Tournapull Rear-Dump saves time in the cut and dump... delivers more tonnage per day.

U-Turn Widths

Model	Tonnage	Length	Bowl Down	Bowl Raised
B	35	36'7"	35'0"	27'0"
C	22	29'6"	28'8"	20'8"
D	11	24'10"	24'8"	18'8"

R-1898-G-1

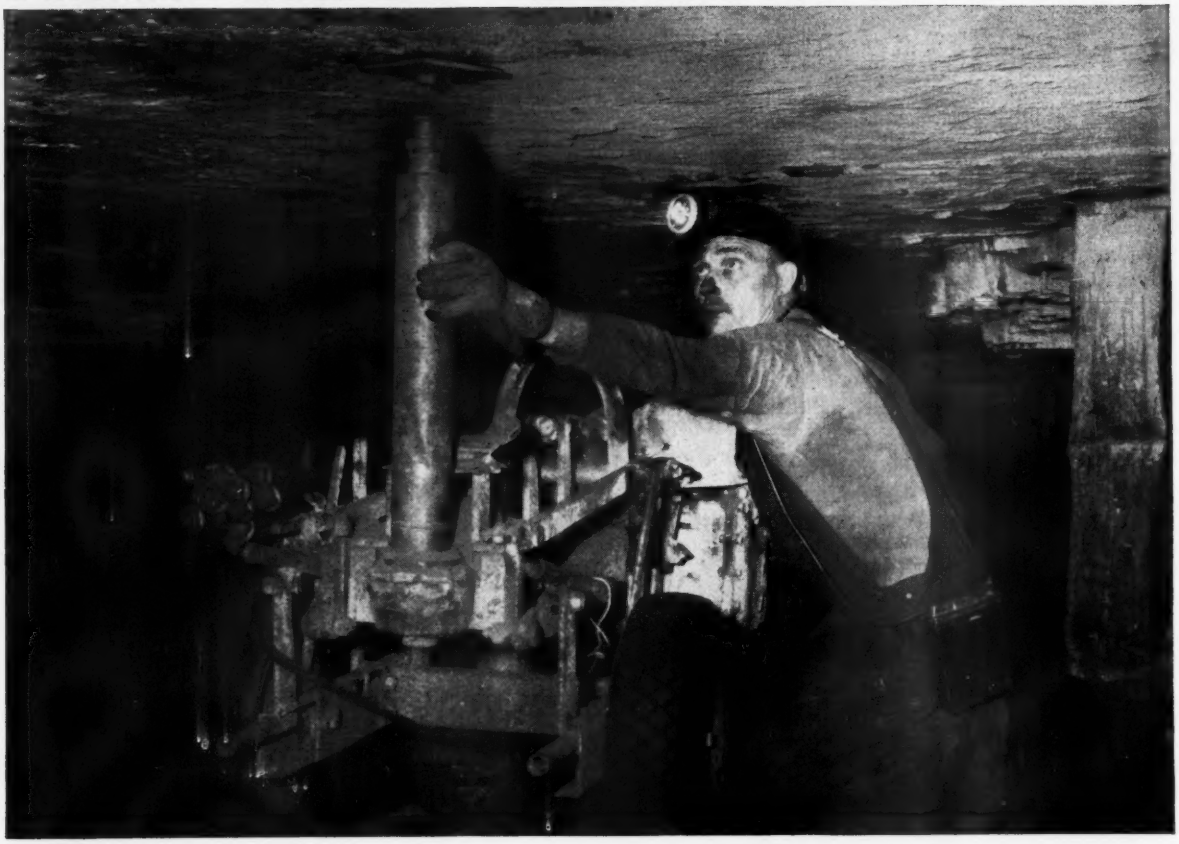
Ask for full specifications on L-W Rear-Dumps

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

NEW ROOF BOLTING UNIT



drills roof and sets bolts in jig time trams itself anywhere

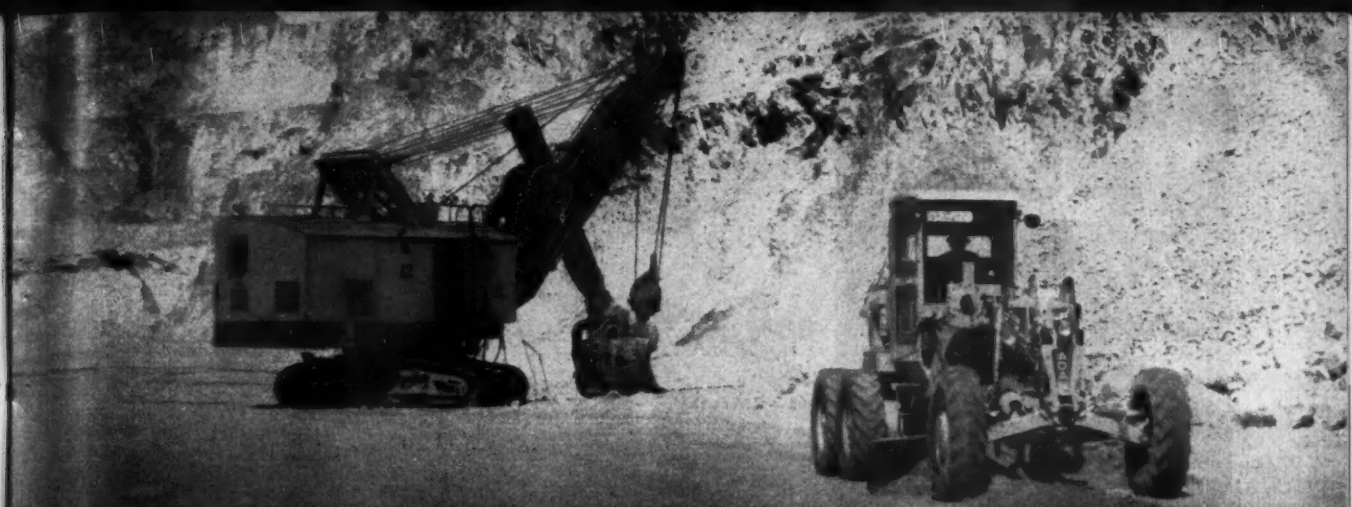
You get *new speed* and *new safety* with the RBD-30S-579. This roof bolting unit completes the whole bolting cycle from drilling to bolt setting in less than 3 minutes. *New* fully enclosed dual-wheel drive has separate tramming motor with push button control. Gives instant forward . . . stop . . . reverse.

This rig drills holes exactly right in size and direction. No dog-legs! No wobbling! No dwelling! That means safe, positive bolt installation. *New* stepped-up motor gives you 30% more power for drilling and bolt setting. Built-in clutch slips on overload to prevent stalling.

New built-in cooling fan pulls heat away from enclosed motor, adds life to insulation. RBD-30S-579 furnished with low speed spindle adapter for slow speed drilling and low seam drilling attachment. Available with water swivel attachments. Write for complete details.

Chicago Pneumatic 8 East 44th Street, New York 17, N. Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES



Pit-and-Plant Housekeeping needs doing every day!

Your clean-up tasks pay no direct profits. But if neglected, they can give you ore-grading troubles, increase hauling costs, add to equipment-maintenance, and cause downtime that cuts production. One man and a modern motor grader earn extra profits by doing necessary "housekeeping" chores day-by-day. This full time clean-up service costs no more than allowing conditions to get so bad you must handle them as emergency projects.

That is why you will find a modern L-W Adams† grader on a regular program of mine "housekeeping" will be a real money-saver for you. Here is a list of everyday assignments you should probably include among your "housekeeping" problems:

1. Haul-road maintenance... saves tire wear, speeds hauling, improves safety, lessens operator fatigue, cuts costs, increases profit.

2. Clean-up of pit floors... permits driving equipment by shortest route, saves wear on tires and crawlers, improves pit drainage, keeps dirt and refuse from weathering into lower levels of ore.

3. Clean-up after blast... the sooner scattered fragments from blast are moved back against toe, the safer for men, tires, and machines that move around your pit.

4. Clean ore-benches of washed-down dirt... the better your grade of ore, the better your price. Leaving silica and other washed-in debris on your benches invites it to wash into crevices and drill holes in your ore. Prompt grader-service stops "wash," piles material for easy removal.

5. Keep concentrating-plant area clean ... safe to work around... drive around. There is occasional spill over the sides of heaped trucks, around conveyors, grizzlies, hoppers, trestles. It pays to clean it up... daily.

6. Keep toes of stockpiles pushed in ... they contain valuable merchandise. Weather and loading operations tend to spread stockpiles, eat up valuable work-space, waste stored material. To load from thinly spread toe gives inferior grades, increases loading cost.

7. Keep drainage open... don't let puddles stand. Your pit area continually needs new drainage ditches. As old ditches fill, you need to clean them out.

8. Level dumps... so trucks can move in faster. An L-W Adams travels up to 27 mph... quickly gets up on the dump, cleans-up, and gets back to the pit... working the haul-road both ways.

9. Snow and ice removal... blade-grading... quickly cleans pit and plant roads for safe, fast hauling. If there are drifts to lick, a V-plow or Snow-Blo wing attachment on your L-W grader helps open blocked roads quickly.

10. Exploration work... a modern motor grader to build and maintain haul-roads is a "must." Once heavy clearing is out-of-the-way, an L-W Adams heavy-duty grader can build you a mile of well-graded-and-drained highway in a matter of hours.

It may be a good idea now to make a survey of your pit-and-plant "housekeeping." Check, too, your available graders... compare them with the workability and versatility of a modern L-W Adams. Perhaps it's time for a change? A new broom sweeps clean ... a new Adams could revitalize your "housekeeping" program! Write for more information. If you'd like reprints of this advertisement to use in discussing "housekeeping" with your staff, just tell us how many copies you need.

A size ADAMS for every need

POWER-*Flow*®
660 — 190 hp diesel engine, 27,850 lbs.
POWER-*Flow*
550 — 135 hp diesel engine, 24,575 lbs.
Model 660 —
160 hp diesel engine, 27,730 lbs.
Model 550 —
123 hp diesel engine, 24,325 lbs.
Model 440 —
115 hp diesel engine, 22,795 lbs.
Model 330 —
80 hp diesel engine, 21,320 lbs.
Model 220 —
60 hp diesel engine, 14,435 lbs.

POWER-*Flow* models are torque-converter equipped. Weights shown are with standard equipment.

Adams optional equipment includes bulldozer, Jebco Elegrader, scarifier, snow plow, and snow wing.

†Trademark G-1814-M-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

Tuffy® Wire Rope Tips

Guard Against These Killers!

... Get The Full Measure of Service-Life Built In By Wire Rope Specialists

Mangled in a Wedge Socket

Here's a result of improper socketing. It was caused by using a poorly designed or worn-out wedge socket. Failure at the dead end can damage other sections of the rope, too.

Rusty Road to Ruin

Rust—No. 1 enemy of steel—takes a heavy toll in wire rope life. An insidious, silent type of killer, rust often does irreparable damage before it's even noticed. The one-strand break shown here resulted when the rope was allowed to become rust-bound through lack of lubrication. Tests show that, with other conditions ideal, properly lubricated rope has up to 10 times the life expectancy of dry rope.

Tuffy Balanced Scraper Rope

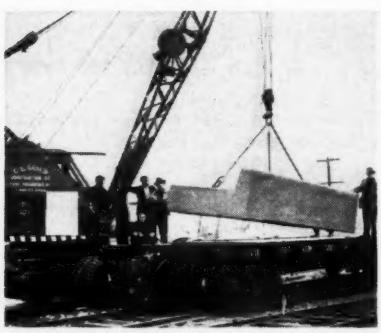
"Balanced" construction makes it flexible enough to withstand sharp bends, yet stiff enough to resist looping and kinking when slack. Also gives higher resistance to the shock of load impact on slack line. Moves more yardage per foot because it's specially built to take the beating of drum-crushing abuse.

Overloaded — Soon Exploded

The rated capacity of a wire rope is based on the breaking strength (catalog) divided by a safety factor applicable to the type of service or use. The grade of steel, type of construction and size of the rope determine tensile strength. It must be properly related to the loads it will carry, or costly and dangerous early failures are likely to occur.

Victim of the Bends

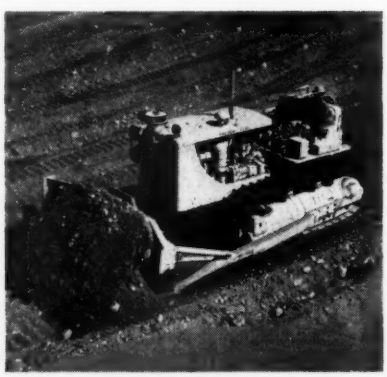
Excessive bending of wire rope accelerates wear. Generally, more flexible ropes are used as bending stresses increase (with decrease in tread diameter of sheave or drum). If a rope is operated on a sheave too small for its bending characteristics, early failure is certain. Through an exhaustive series of bending tests, Union Wire Rope engineers have compiled data that you can use to assure getting the rope construction that will give you the longest service life. Ask about it.



Tuffy Balanced Slings & Hoist Lines

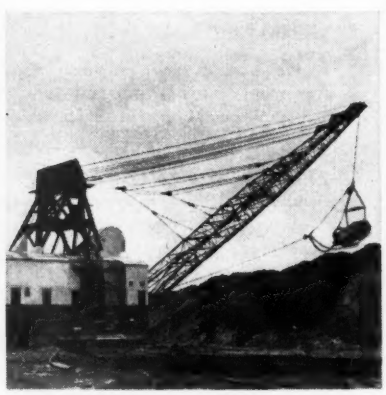
"Balanced" because they combine strength, flexibility and toughness in the proper relationship to do a better job longer.

Tuffy Slings and Hoist Lines are a top-performing team in every type of materials handling. The slings are made of a patented, machine-braided fabric that's next to impossible to knot or kink. The hoist lines are a special construction in which strength, flexibility and toughness are balanced.



Tuffy Balanced Dozer Rope

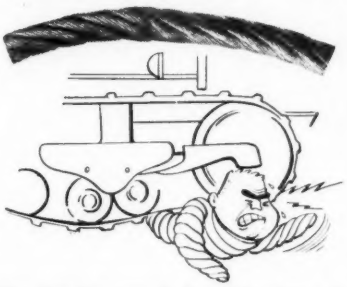
Built to give you longer service with less downtime. Mounted on your dozer, a 150' reel of ½" or 9/16" can give you a big bonus of extra service. Here's how: when rope shows drum wear or is crushed on the drum, you feed through just enough to replace the damaged part. You save the 40 to 50 feet ordinarily thrown away. Also available in 300' and 500' reels.



Tuffy Balanced Dragline Rope

Here's highest abrasive resistance with super flexibility. Better spooling. Smoother riding on grooves. And Tuffy Dragline Rope hugs the drum when casting for full load. Gives you longer service life, consistent dependability, in handling any material — wet or dry dirt, sand, gravel, rock, cement or minerals.

Crushed by a Tractor Cleat

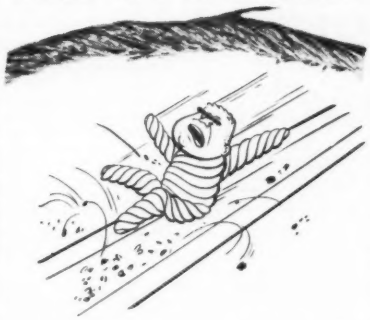


The Sunday punch for this piece of wire rope was delivered by a tractor cleat—just one of many crushing injuries caused by rope being run over or banged into by hard, sharp objects. Even the toughest wire rope is no match for this kind of mistreatment.

After a Suicide Jump

This rope jumped out of sheave and was soon destroyed by pulling around the shaft. Actually it was a case of sudden slack which threw the rope out of the sheave.

Burned on a Frozen Sheave



End of the line came quickly for this rope as the result of operating over a sheave that did not turn. Note the exceptionally heavy abrasion on one side of the rope. Sheaves should be checked thoroughly and often.

"Real Gone" From Beatings on the Drum

Even under normal operating conditions, drum wear gives wire rope severe punishment. This wear concentrates at the cross-over points and at the flange. Excessive drum crushing results from operating on small drums, excessive loading and poor winding. Smooth drums are not recommended. Here are typical "drum beatings": Cross-over wear; cross-over crushing on drum; drum crushing from poor winding; drum-crushing from small drum.

Although drum wear cannot be eliminated, its effects can be greatly reduced. Under properly engineered procedures, two and three times the service can be obtained from the same line by improving drum conditions. Union Wire Rope Engineers will help you with this problem. Get in touch with us for information.

On the "Blink" from a Kink

This open kink resulted from mishandling of rope. Guard against kinks by proper winding on the drum. Never pull a loop smaller. Always enlarge it, then straighten out the rope.

Strangled by a Misfit Sheave

When the bearing surface of a sheave is too small for the rope diameter, pinching action quickly destroys the rope — especially when it's overloaded. The victim shown here was knocked out in just 1½ hours of service.

Tuffy Wire Ropes are "Job Prescribed"—Each Designed for a Particular Type of Machine

There are thousands of wire rope constructions and Union Wire Rope specialists make them all. But, there is only one Tuffy line of wire ropes. Each Tuffy was developed and proved the one best rope for the particular work for which it is intended. It is designed as a functional part of the type of machine on which it is used.

Tuffy Wire Ropes are "job prescribed" and balanced in each prescription are all the ingredients of strength, flexibility and toughness to give you genuine relief from inefficient operation, foreshortened service life and safety hazards. You get longer service life and you cut down on your rope costs. Union Wire Rope Corporation, 2144 Manchester Avenue, Kansas City 26, Missouri.

Your Tuffy Distributor Can Help You Get The Full Measure of Service Life

C1

UNION Wire Rope

Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company
Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Southwest Steel Products

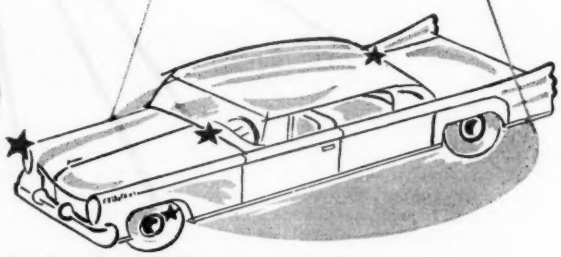
SULPHUR ONE OF THE FOUR STRONG PILLARS OF PROCESSING

INVISIBLE

BUT PRESENT

35 POUNDS OF SULPHUR

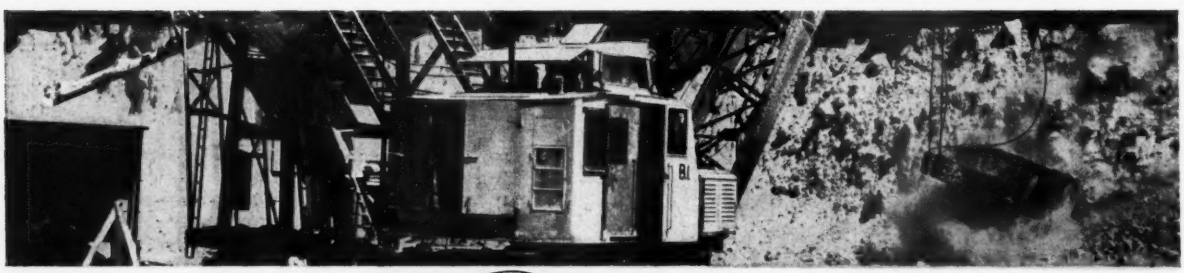
and derivatives help to produce the average automobile



Sulphur enters the automobile picture in two ways: directly and indirectly.

Sulphur, either as the elemental or as one or more derivatives, is used in the manufacture of rubber and rayon. Indirectly, it is used in processing the steel that forms the body. It is used in the plating operation on trim and fixtures. It is deliberately introduced into certain steels to provide better machining qualities.

Recognizing the importance of Sulphur to the basic industries such as the manufacture of automobiles, and to our ever-expanding economy generally, TGS is broadening its service: production, distribution and technical.



SULPHUR PRODUCING UNITS

- Newgulf, Texas
- Spindletop, Texas
- Moss Bluff, Texas
- Worland, Wyoming
- Fannett, Texas

TEXAS GULF SULPHUR CO.

75 East 45th Street, New York 17, N.Y.
811 Rusk Avenue, Houston 2, Texas

Questions

We've been asked about the Yieldable Arch

"What kinds of mine can use the Yieldable Arch?"

The Yieldable Arch can be used in practically any type of mine where soft or heavy ground causes spalling or squeezing conditions. Yieldable Arch installations are being used in almost every type of mine you can think of—anthracite and bituminous coal, iron, copper, lead, zinc, nickel, bauxite, limestone, and asbestos.

"In our bituminous coal mine we have no problem with heavy ground or subsidence. What would we have to gain by putting in Yieldable Arches?"

It's true, of course, that roof control is the primary function of the Yieldable Arch. But it is only one of the benefits to be derived from a sound Yieldable Arch installation. We could cite a number of instances similar to yours, where Yieldable Arches have already paid for themselves through sharp reduction in maintenance expenses.

Send Us Your Questions: You probably have other questions of a specific nature concerning the application of the Yieldable Arch to your mine. If so, by all means send them in; we will study your questions and reply as promptly as possible. Write: Room 1041, Bethlehem Steel Company, Bethlehem, Pa.

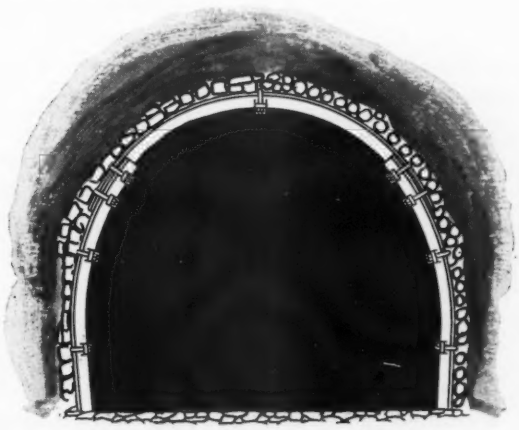
For example, even though you may have no subsidence problem, it's quite likely that spalling occurs or the entry may be subject to heavy roof falls, endangering personnel and requiring substantial clean-up time. Then, too, the Yieldable Arch is a long-service mechanism which will keep haulways and drifts open and clear almost indefinitely. Thus it is ideal for coping with such conditions, eliminating the time and money ordinarily spent in support-renewals and clean-up of falls.

A good job of lagging goes hand-in-hand with a good Arch installation. Lagging and packing act as a cushion; they fill in the voids between mine roof and Arches, keep the load on the Arches relatively uniform. Lagging may be either poles, planks, or timbers, or even old steel ties (see sketch below).

If you should consider the reopening of caved areas of old workings, Yieldable Arches will prove ideal in making and keeping the entries workable.

. . . . . .

Bethlehem's Yieldable Arch is made of U-shaped rolled steel sections. An Arch set is built up of three or more segmental lengths nested at the overlapped ends, and clamped together with U-bolt clamps to form a friction joint. This joint is designed to yield under excessive pressures, before deformation occurs in the steel, thus maintaining structural integrity in the arch while permitting the ground to relax gradually. Its success in mines all over the country can be described as little short of phenomenal.

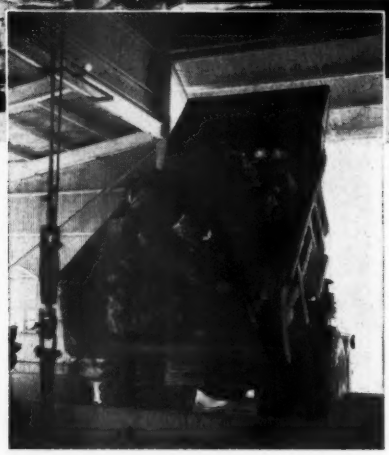


Poles, planks, steel ties make good lagging.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corp. *Export Distributor:* Bethlehem Steel Export Corp.

BETHLEHEM STEEL



"Euclids give us good service with low maintenance and keep our hauling costs at rock bottom"

LOUISVILLE CEMENT COMPANY, SPEED, INDIANA

Six 22-ton Euclid Rear-Dumps are hauling mortar stone, Portland cement stone and overburden at the Speed, Indiana, quarry of Louisville Cement Company. Working an 8 hour shift, three of these "Eucs" handle 400 tons per hour on hauls ranging from 1000 to 3000 feet. The wide bodies with struck capacity of 15 yards are loaded by a 4½ yd. shovel in four passes. Two other units are loaded by a 2½ yd. shovel. With loaded speeds up to 30 mph, they average 80 tons per hour on a 2 mile one-way haul. In addition, three of these "Eucs" work a second shift hauling overburden.

Louisville Cement Co., like hundreds of mine and quarry operators, has found that Euclid equipment moves more tons at lowest operating and maintenance cost. Dependable Euclid performance is the result of advanced engineering, rugged construction and almost 25 years experience with off-highway haulers.

To be sure you have the most economical hauling equipment, get a production and cost estimate from your Euclid dealer on the model best suited to your work — you'll find there are a lot of reasons why ***Euclids are your best investment.***

EUCLID DIVISION GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

GM GENERAL MOTORS EUCLID

EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE

"Not merely to sell; but to serve . . . not only to make good steel products; but to make them still better . . . not only to fulfill today's requirements; but to anticipate tomorrow's—these are the principles that constantly guide CF&I."

G. F. Evans
President

Grinding Mill Bulletin #4

In line with our company policy—service as well as sales—CF&I is presenting this series of ads on grinding ball rationing in the makeup charge. We trust that these ads will help grinding mill operators—by providing information that will help increase the efficiency and productive capacity of their ball mills.

General Method of Rationing the Makeup Charge

These facts have been outlined in previous ads in this series: (1) that determining the optimum size assortment of grinding balls for a makeup charge is a practical means of improving mill operation; (2) that the best makeup charge of one-size ball should be established before a rationed makeup charge is attempted; (3) that over-size ball additions are preferable to under-size additions in general, although both reduce mill efficiency; (4) that radical changes in the size of the balls to be added is not good practice. Now let us look at methods that are regarded as good practice.

If it is determined that there is a shortage of small balls in the seasoned charge, part of the makeup charge may be made up by smaller balls of one or more sizes. If there is a problem of tramp oversize in the grinding circuit, a portion of the makeup charge may be replaced by a ball of larger diameter.

In many cement plants, the seasoned charge in the mill contains too many balls that have worn to small and irregular shapes—so that they give ineffective contact. These small and "cull" balls take up space that could be better utilized by larger spherical balls which would grind more effectively. In order to increase the ratio of larger balls in the charge, the mills are periodically dumped; the charge screened; the larger balls returned to the mill; and new balls are added to make up for those cull balls which are removed.

Steps In Working Out The Ball Ration

Complete records should be kept:

(1) so that the throughput of the mill, ball wear and power consumption are known. It is also well to record liner wear, although this requires observation over a long period of time.

(2) of feed, discharge, classifier overflow, and classifier sands screen analyses. Classifier sands size structure will give indications as to whether smaller or larger balls in the charge will give better results.

(3) to show the effect of any change in ball addition on: the mill throughput, power consumption per ton and ball wear in pounds per ton. These changes will affect the size structure of the mill discharge as well as the classifier overflow and sands.

Before it is assumed that the full effects of a change in ball additions have occurred, the ball wear pattern should be given time to reach its new equilibrium. This will involve the amount of time required for the old ball charge to be entirely replaced by the new charge. For example, if the ball load in the mill is to be maintained at 100,000 lbs., and 1000 lbs. of balls are added per day to maintain that ball level, it is reasonable to assume that more than three months will be needed in which to complete the modified ball charge.

If the new makeup charge is one that would increase the rate of comminution of the ball mill, and *if* the new ball charge reaches its equilibrium *without* an increase in feed rate: the new charge will *not* show an increase in throughput; the steel consumption will be too high—due to steel on steel wear; and steel consumption per ton of ore ground will be unnecessarily high. Therefore, to prove the value of a change in ball ration, it is important that care be exercised to keep the mill feed at capacity at all times.

Rules, studies and formulae for analyzing classifier sands data, mill feed or dumped ball charges, are discussed in the article on which this ad is based.* Too much space would be required to cover this material here. However, CF&I's mining department engineers are thoroughly familiar with good practices in grinding ball operations, and are ready to help you with your specific problems. CF&I is also ready to provide special analysis steel grinding balls which will give you maximum production efficiency in your grinding mill. CF&I Grinding Balls are available in all standard diameters from 3/4" to 5". They are carefully inspected throughout production and immediately prior to shipment to ensure that they are free from surface pits, circumferential ridges or other surface defects. You'll find them ideally suited to helping you work out the correct ball ration for your specific operations.

**For a reprint of the article on which this series is based, please write on your company letterhead to: Mining Supply Department, The Colorado Fuel and Iron Corporation, P. O. Box 1920, Denver, Colorado.*

OTHER CF&I STEEL PRODUCTS FOR THE MINING INDUSTRY

CF&I Grinding Rods · CF&I Grader Blades · CF&I Industrial Screens
CF&I Mine Rail and Accessories · Wickwire Rope · CF&I Rock Bolts

FORGED STEEL GRINDING BALLS
THE COLORADO FUEL AND IRON CORPORATION

Albuquerque · Amarillo · Atlanta · Billings · Boise · Boston · Buffalo · Butte · Chicago · Denver · Detroit · El Paso · Ft. Worth · Houston
Kansas City · Lincoln · Los Angeles · New Orleans · New York · Oakland · Oklahoma City · Philadelphia · Phoenix · Portland · Pueblo
Salt Lake City · San Francisco · San Leandro · Seattle · Spokane · Wichita 6120

The Right Climate For Underground Operations

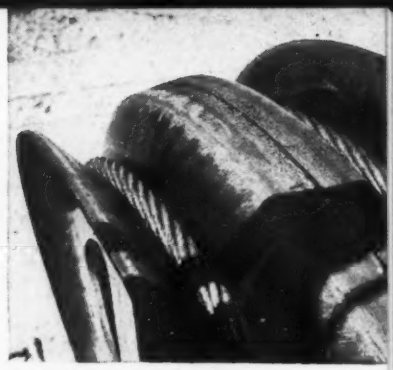
Keeping underground working areas free of gases and fumes and supplying fresh air for tunnel work is no problem when you use NAYLOR Spiralweld pipe lines.

This dependable pipe is light in weight, easy to handle and install, strong and safe in service—particularly on push-pull ventilating operations. And when you make connections with the NAYLOR one-piece Wedgelock Coupling, you can set up lines quickly with just one side of the pipe in the open. **For the details, write for new Bulletin No. 59.**

NAYLOR PIPE *Company*

1278 East 92nd Street, Chicago 19, Illinois

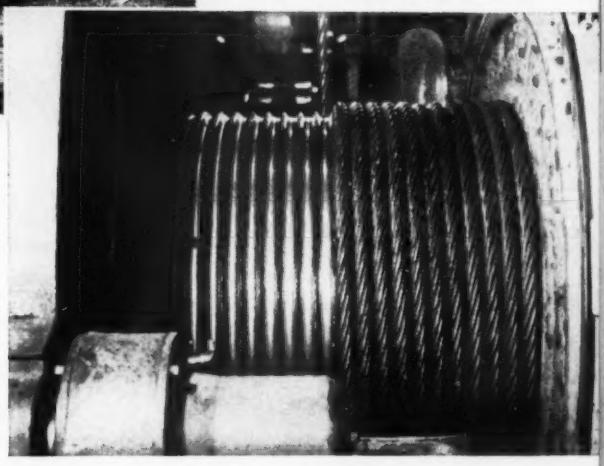
Eastern U. S. and Foreign Sales Office: 60 East 42nd Street, New York 17, N. Y.



2⅜" Tiger Brand hoist ropes going through the boom point sheaves.

40-cubic-yard shovel stripping overburden at the Little Sister Mine of the Truax Traer Coal Company, St. David, Illinois.

Main hoist drum with well-lubricated Tiger Brand Rope in excellent condition after long service.



Little Sister Shovel has big "muscles" of Tiger Brand, America's No. 1 Wire Rope

This 40-cubic-yard shovel, owned by the Truax Traer Coal Company, has been removing overburden at the Little Sister Mine near St. David, Illinois, for more than nine years. The hoist line is a 550-foot, 2⅜-inch diameter Tiger Brand Wire Rope, and the four boom supports are also Tiger Brand.

During this period, millions of cubic yards of rock and earth have been moved, and the Tiger Brand Wire Ropes have given long service life and dependable operation.

Since this 40-cubic-yard shovel went into service, we have seen the size of big shovels advance to 55, 60 and 70 cubic yards . . . and most of these big strippers are equipped with American Tiger Brand Wire Rope. Why? Because Tiger Brand is quality-controlled from ore mines to finished product under the direction of one of the finest wire rope engineering staffs in the country. They can utilize any of the basic research being conducted by United States Steel Corporation. What's more, they have unsurpassed plant facilities to produce the largest or the smallest wire rope you need. That's why Tiger Brand gives you longest service at least cost.

Write now, for our latest booklet on wire rope. American Steel & Wire Division, Rockefeller Building, Cleveland 13, Ohio.

USS and Tiger Brand are registered trademarks

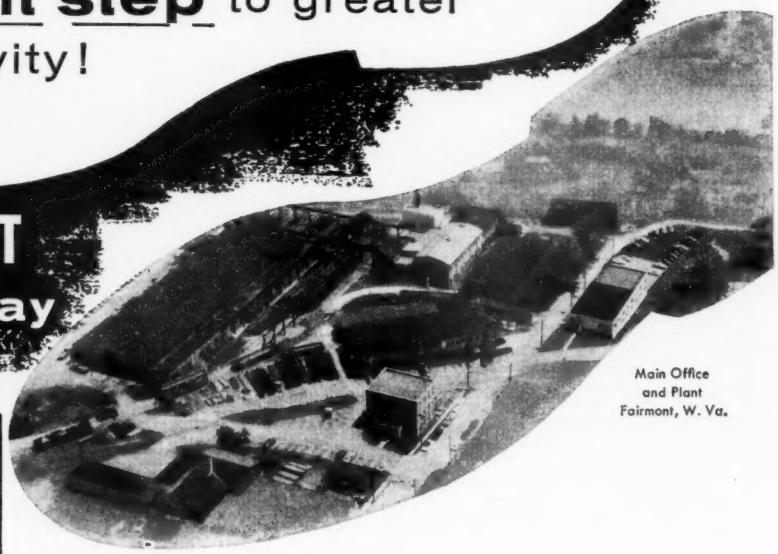
American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, Distributors Abroad

Today's preparation and handling equipment takes a giant step to greater productivity!

and

FAIRMONT shows the way



Main Office
and Plant
Fairmont, W. Va.

UNLOADING

Car retarders and hoists, car shakers, unloaders, rotary-car dumpers, portable conveyors, track hoppers, grizzlies, feeders, weighing devices.

TRANSFER

Skip hoists, bucket elevators, belt and flight conveyors, mass-flow and screw conveyors, stacking conveyors.

PREPARATION

Crushers and breakers, screens and dryers, washing equipment.

STORAGE

Bins, bunkers and silos, bin flow devices, indicators and alarms, vibrators, gates and valves.

IN-PLANT HANDLING

Conveyors, elevators, chutes, scales, meters and samplers.

Ever changing conditions and demands by industry pinpoint requirements that depend more and more on systems and modern machines geared to the tempo of the age!

Coal, a major industry, is part of this trend to greater productivity and improved quality. Fairmont Machinery, with over 60 years experience, is keenly alert to these rapidly changing times and is making every effort, through research and development, to provide you, the operator, with the most efficient and economical methods for handling, preparation and storage.

Fairmont is equipped and ready to produce for you—whether a complete preparation or cleaning plant; an entire or partial operating system; or the modernizing of your existing facility.

Why not call us today for a get-together with you.

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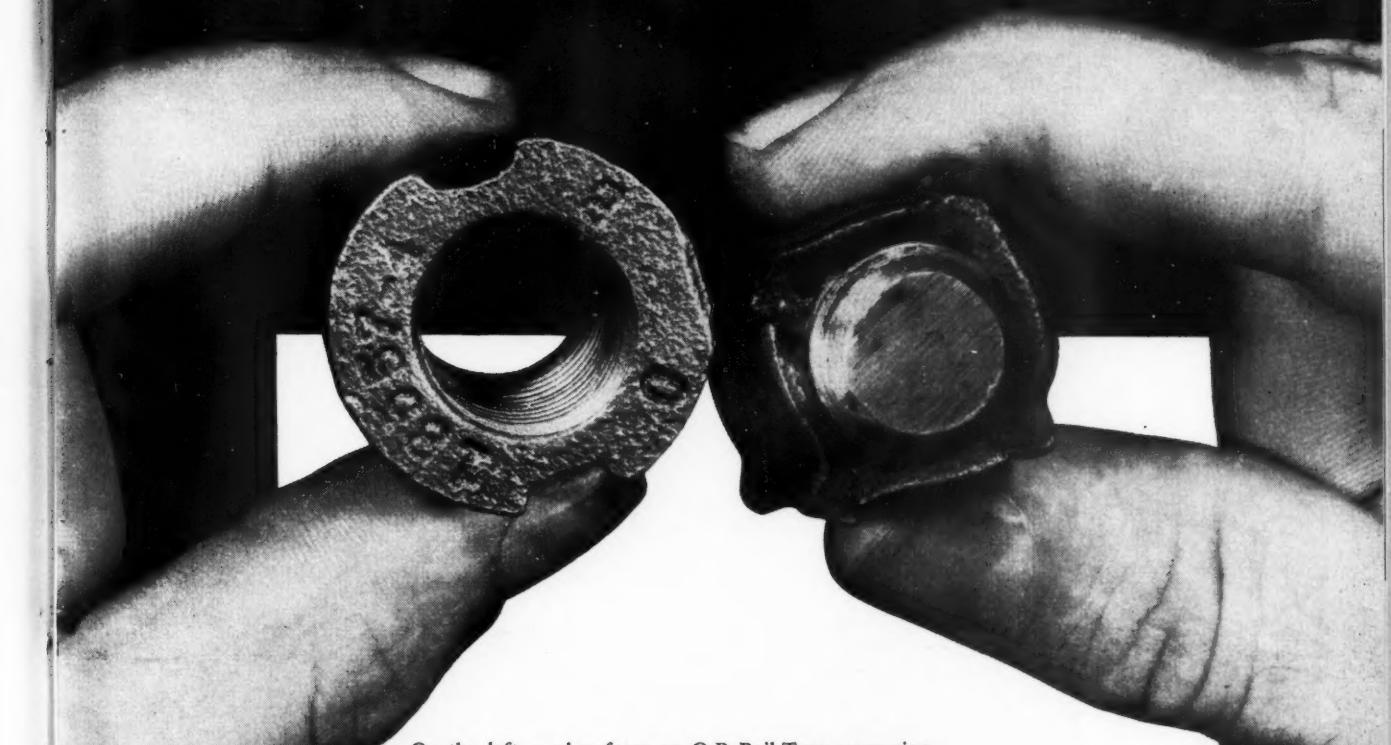
ENGINEERS • DESIGNERS • FABRICATORS and CONSTRUCTORS

27 TON pull test shows 4-way expansion of O-B Shell and Plug!



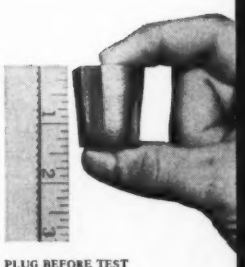
On the left, a plug from an O-B Bail-Type expansion unit. On the right, an identical plug after tensioning to 54,000 pounds — *6 times* the normal bolt load!

The test was made with a special bolt installed in a 1⅜ inch hole drilled in quartzite by an O-B customer operating a South African gold mine.

As shown in these unretouched pictures, the plug was compressed 22% and elongated over 30% by the tremendous pressures exerted against it. But, because those expansion pressures were distributed evenly four ways, reducing unit stresses to an absolute minimum, the O-B plug refused to break and release the bolt.

Four-way expansion is *another* reason why "they go up easy *and stay put!*"

OHIO BRASS COMPANY, MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd., Niagara Falls, Ont.



PLUG BEFORE TEST

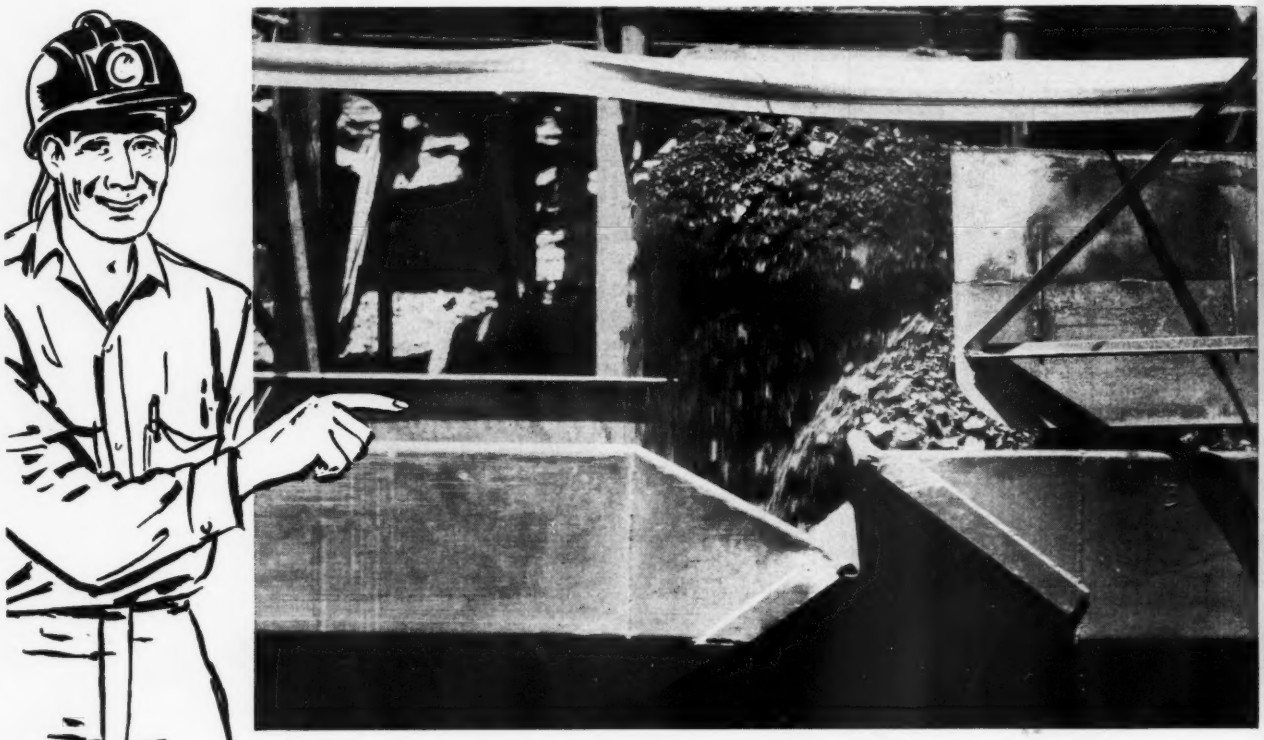
PLUG AFTER TEST

Ohio Brass

O B
SHELLS AND PLUGS

4827-M

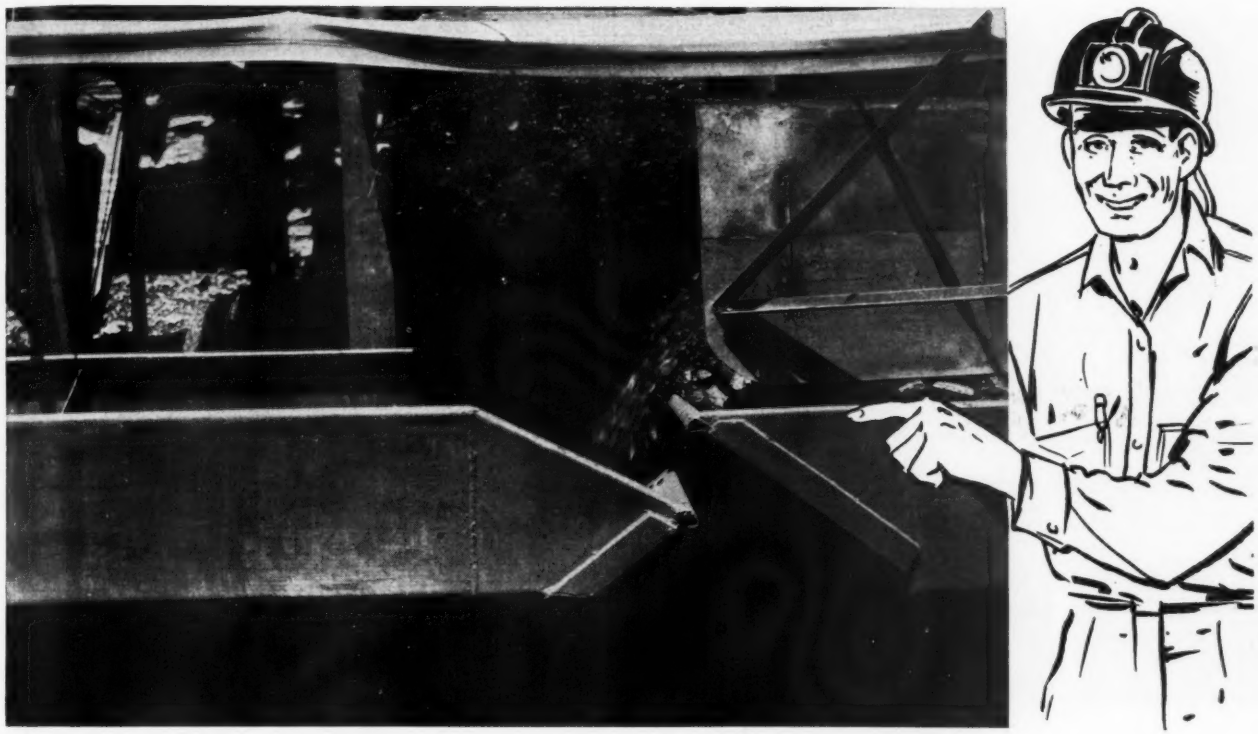
"Here, in unretouched pictures, why S-D Automatic 'Overlapping haulage cost to the



Note coal continues to flow from chute directly over exclusive S-D Automatic "Overlapping Ends" — without spillage between-cars. Photographer shot this picture while trip was in-movement.

This still-shot shows the Top Dresser Bar and Side Dresser Plate, which automatically dress the cars as they are automatically loaded!

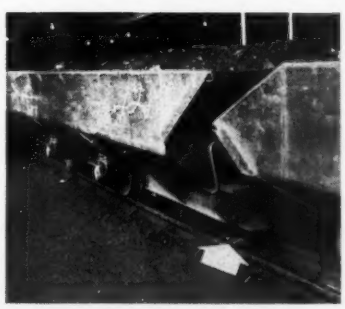
is shown one of the basic reasons End' Cars will reduce your absolute minimum..."



We had chute discontinue loading at the moment this picture was shot so you could see that in actual operation two things take place: (1) as mentioned, flow of coal continues uninterrupted and also (2) after dressing car to underground haulageway height, surplus coal is plowed into next car in trip—thanks to S-D "Overlaping Ends."

EVERY YEAR, without exception, more mines convert to the S-D Automatic Car Haulage System. What are the reasons?

1. Since the mining operation at the face and the preparation of coal for shipment are separate and distinct functions, operators want them to be carried on independently, so that each may operate in the most economcial manner . . . in other words, so that no interruption or slow down in one will interrupt or slow down the other. They want the system that will continuously remove coal from the loading point as it is mined, and, at the same time, will provide a continuous supply for the preparation plant. Automatic Bottom Dumping Mine Cars are the only known means of low cost coal mine transportation that will allow a continuous movement of coal from the face, or loading point, to the railroad car. Reason for this is because these cars are the only method of haulage that can use a low cost, low maintenance, large capacity SURGE BIN, which serves as a temporary storage for coal in transit and thereby balances the mining and preparation operations.



Automatic Dumping ON-THE-MOVE!

2. Lower initial capital cost — 40% fewer cars required . . . fewer locomotives . . . rotary dump requires special dump at high cost . . . cleaning plant may be of smaller capacity because it does not have to handle all the coal as quickly as it is mined.

3. Lower operation cost — fewer cars, fewer locomotives . . . no rotary dump to operate and maintain . . . no dumping labor, and with S-D "Overlapping End" Cars no loading labor!

4. Greater flexibility — cars of any size and dimension can be dumped over same SURGE BIN, provided each has same track gauge, of course. Double tracks can be used over bin where desirable. No tilting chutes or other similar mechanisms required at loading points; therefore, less headroom and less capital cost, plus minimum time required for moving loading set-up! No other coal haulage system gives the flexibility provided by Automatic Bottom Dumping Car Transportation!

These are some of the fundamental reasons why the S-D Automatic Bottom Dumping Car Haulage System reduces cost to the absolute minimum. How much can you save? We recommend a fact-finding survey by our Application Field Engineer. No obligation, of course. May we get together? Write or call us today!

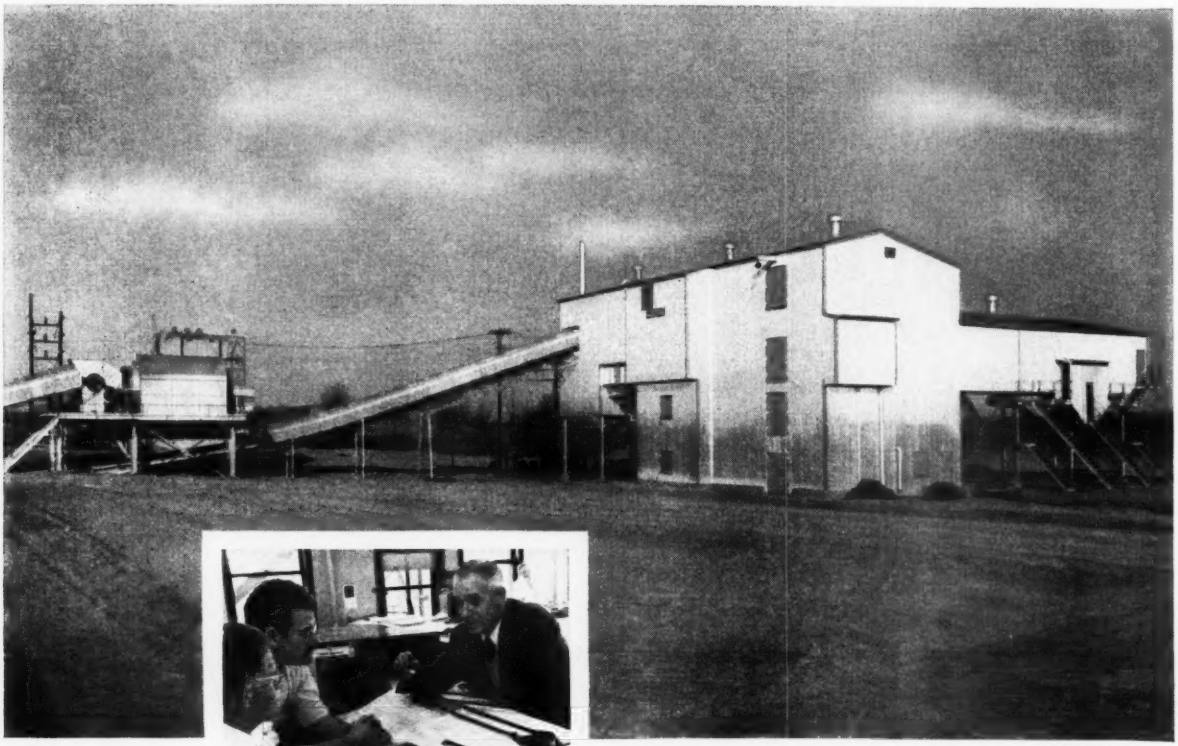
Sanford-Day Iron Works, Inc., Knoxville, Tenn.

SANFORD-DAY

KNOXVILLE, TENNESSEE

A NEW PLANT

...for the WEIRS CREEK COMPANY



Designed, Engineered and Built by

Roberts & Schaefer

When you plan a new coal cleaning plant, you'll find it pays to talk with Roberts & Schaefer. What's your problem: a complete new plant . . . installation of new facilities . . . or a complicated dismantling, moving and rebuilding job? Whatever your requirements, Roberts & Schaefer will deliver a plant with the capacity, flexibility, efficiency and operating economy you need. R&S service is as comprehensive as you want it: initial process studies . . . structural, mechanical and electrical engineering design . . . installation of all facilities . . . and complete construction.

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THE NEW
WEIRS CREEK COMPANY
SHAMROCK MINE

This is a jig plant near Providence, Kentucky, which is designed to wash 500 TPH of West Kentucky coal, seams #9, 11 or 12. The ROM coal is weighed on a belt scale and then reduced to a minus 6" size by a Bradford Breaker. All of the coal is washed in a Baum-type jig and the middlings are rewashed in a diaphragm jig. The fine coal is dried in a centrifugal dryer.

It pays to talk with Roberts & Schaefer

MINER'S PICK

The right heft and a sharp point always. Points of highest quality heat-treated tool steel are set in tapered sockets, easy to renew when worn. Heads made from special steel, properly designed for weight and balance.

No. 6-10 Complete with handle and two points

No. 6-2 Points only

The BOWDIL COMPANY . . .

CANTON, OHIO Phone GLendale 6-7176

ROPE SOCKETS

Installs in a jiffy—without tools. You just position the rope, place wedge shaped cap on. The greater the rope tension, the tighter it holds. Offset eye design allows straight out pull, a big safety and strength feature. High tensile alloy steel, heat-treated.

7-4A	½" ROPE
7-6A	⅝" ROPE
7-7A	¾" ROPE

NEW ACME HI-LIFT

MODEL HSHL-4B

For Best Results in High-Vein Roof Bolting

The ACME (Model HSHL-4B) HI-LIFT is an innovation in modern mining technique designed to facilitate roof control in high-vein mining operations. The ACME HI-LIFT is a four-wheel drive, tractor type steering, unit with an elevating drilling deck on which are mounted two traveling and traversing Le Roi S12VT Nu-Matic stopers. The elevating platform enables the operator to work at the most convenient height for greatest efficiency. The stopers move on a traveling rail thereby permiting drilling at virtually any spot on the platform. The drills are of the integral dust collecting type and the dust collectors are mounted beneath, and on the sides of, the platform. Safety timbers can be placed between the platform and the roof to afford protection to the operator from roof slabbing and falls. The platform will support a 30,000 pound weight and can be tilted 15 degrees front to back. In addition the ACME HI-LIFT has four leveling jacks with an effective stroke of 10″ for leveling in bad bottom or on high grades. Two complete sets of controls are furnished as standard equipment, one being on the platform and one on the tramming deck. A powerful 40 HP motor drives the complete hydraulic system for the unit.

COMPLETE SPECIFICATIONS WILL BE GLADLY FURNISHED UPON REQUEST

ACME MACHINERY COMPANY

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REPRESENTATIVES IN PRINCIPAL MINING AREAS

The Standard of Comparison for GRINDING ECONOMY

Sheffield alloying, forging and heat treating techniques assure the right combination of hardness and toughness—right to the core of the ball. Result: longer service life, less down-time, greater production economies. Something to remember next time you order grinding balls.

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NOW-

NEW BATTERY PLATE CONSTRUCTION

Unique new double-sleeve, multi-tube positive plate construction permits greater volume of active material per tube and greater accessibility of electrolyte to the material — providing greater capacity for brighter, better light with no increase in plate size. Long battery life with increased resistance to vibration and hard use are plus advantages.

A PERFECT SPOT
at your fingertips — either filament!

A finger-turn of the switch knob lights either filament of the powerful equal-filament bulb—and at the same time achieves a perfect, brilliant spot! No tools, no fuss or tinkering. Anyone who can turn a switch can focus an ideal spot with WHEAT—instantly!

— a MAJOR ADVANCE

in better light for the miner!

THE WHEAT National MODEL

MINER'S ELECTRIC CAP LAMP

In a single step, WHEAT moves out front in better light, greater utility, top service for the worker underground! The WHEAT *National* Electric Cap Lamp incorporates advances in battery, bulb and focussing beyond comparison in the field today—retains every factor of dependability, simplicity and ease of maintenance that have made WHEAT the leader in sales increase for the past decade. See your National Mine man now, and talk WHEAT NATIONAL for its very good reasons!

30% MORE LIGHT

at no increase in weight

Advanced, exclusive new battery construction joins with efficient new krypton-filled bulb to achieve unrivalled light output in a miner's electric cap lamp today . . . 30% more light than even the high-powered Wheat Forty-niner! For the *most* light for the miner throughout the working shift, specify WHEAT NATIONAL.

TWO WORKING FILAMENTS

in Krypton gas-filled bulb

Each of the two identical filaments in the new Wheat krypton-filled bulb is a full-power working filament. If one burns out, the other is instantly available at equal high brightness—and is focussed instantly to an equal perfect spot. Only WHEAT NATIONAL offers this operating ease!

National Mine Service Company

Koppers Building Pittsburgh 19, Pa.

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IN CANADA: NATIONAL MINE SERVICE (CANADA) LIMITED Elliot Lake, Ontario

BUCYRUS-ERIE COMPANY uses 14 Timken bearings at critical points in the crowd, main and swing machinery of the "River Queen" to take radial, thrust loads in all combinations.

Giant shovel swings 80-ton bites 300 ft., stacks 'em 100 ft. high, 14 TIMKEN® bearings take the loads

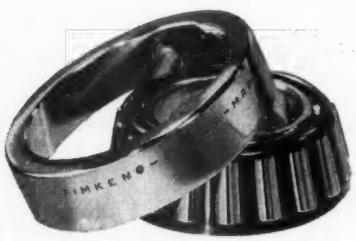
IT'S a whopper!—this Bucyrus-Erie 1650-B stripping shovel. It weighs in at over 2,400 tons, rises 140 ft. high. Taking 80-ton bites of overburden, it can pile up a "mountain" of 100,000 tons in a 24-hr. period. 15 electric motors power the giant, one of the largest mobile land machines ever built in the U. S. Yet one man in an air-conditioned cab controls the entire digging operation.

To take terrific radial and thrust loads 14 Timken® tapered roller bearings are used at critical points in the crowd, main and swing machinery. Their tapered design enables them to take any combination of radial and thrust loads. The full-line contact between rollers and races gives Timken bearings extra load-carrying capacity, too. And they shrug off shock loads; they're case-carburized to have hard, wear-resistant surfaces and tough, shock-resistant cores.

Timken bearings are geometrically designed to roll true. And they're precision-made to live up to their design. They virtually eliminate friction. And by keeping housings and shafts concentric they make closures more effective. Dirt stays out; lubricant in.

We even make our own electric furnace fine alloy steel, for extra quality control. No other American bearing maker does. For your No. 1 bearing value, specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

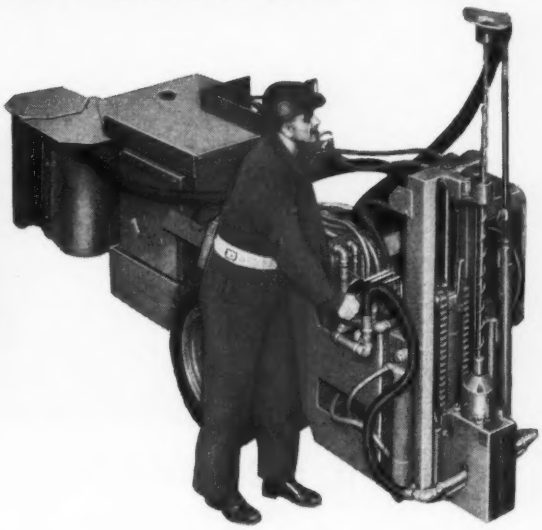
This symbol on a product means its bearings are the best.



TIMKEN TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD

Fletcher EXTENDED-HEAD Roof Drills Bring NEW ACCESSIBILITY OF CONTROLS ...INCREASED OPERATOR EFFICIENCY... For Faster, Safer, Bolt Installation!



FLETCHER Roof Control Drills now provide the advantage of extended head design on all standard models. Operators stand away from the face and away from the rib, *regardless of where bolt is to be installed*. Control handles on both sides of head work in the same direction for easier, surer operation.

Your drillers will find that they can do their job faster with this new control system. *And maintenance men will like the new accessibility of the "packaged controls"*. All valves are bolted to a drop-in plate, permitting them to be removed as an assembly. Fewer hoses need be disconnected to reach the point requiring service . . . and less service is required . . . because of their protected location within the body of the head extension.

Coupled with the advantages of long, fast, telescoping stroke . . . high thrust . . . and all-hydraulic positioning, *FLETCHER Drills give you two-man results with ONE-man operation.* NOW is the time to cut your roof control expense with fast, efficient, economical FLETCHER Drills. Let us talk to you about the new standard designs . . . *or specials to meet your specific requirements.*

FEATURES

- Jack-feed system delivers maximum smooth thrust with quick raise and return.
- Hydraulic lowering device lets you drill directly from the mine floor.
- Hydro-slide moves your drill across the place smoothly, accurately and fast.
- Compact frame and third-wheel steer makes tramming quick and easy.
- Height range from 28-inches to 14-feet lets you select a drill to exactly fit your mine.
- Telescoping mast gives full stroke in varying seam conditions. And the new floor-to-roof mast gives added safety, speed and power.

Fletcher
ROOF CONTROL DRILLS

J. H. FLETCHER & CO. | P. O. Box 2143, HUNTINGTON 18, WEST VIRGINIA
JAckson 5-7811

A 9-ft. deep undercut . . . and four 9-ft. blastholes

Kennametal U10 Cutter Bits, mounted in a Joy 11RU Universal Cutter, cut rapidly across the face, leaving a coarse slack with few fines. These bits, with narrow inserts that draw a small power load, are reground an average of 10 times.

After undercutting, four blastholes are drilled into the face, using Kennametal DL 1⅞" Drill Bits on a Schroeder Hydraulic Drill. Completing a 9-ft. hole takes less than half-a-minute actual drilling time.

IN FIFTEEN MINUTES . . .

two men cut and drill this 18-ft. face . . . using KENNAMETAL* Bits

At the Wyatt-Seanor Mining Company, near Saltsburg, Pa., two men in each section cut and drill coal for two Joy 14BU Loaders and three shuttle cars. In maintaining this pace, where the Upper Freeport "E" Seam runs between 42-in. and 47-in. thick, it takes these two men an average of 15 minutes to prepare an 18-ft. face, from the time they start their sump to the completion of the final blasthole.

Using a conventional mining cycle—undercutting, drilling, shooting and loading out—this mine realizes a remarkable shift tonnage of 32 tons for each man at the face.

Ask your Kennametal Representative how the "Yellow Bits" can improve your production. Let him help you select and actually test in your mine the Kennametal Bit designed to best match your operating conditions. Call your Kennametal Representative or write KENNAMETAL INC., Mining Tool Division, Bedford, Pa. 5767

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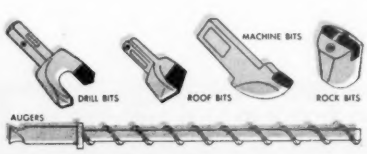


Here Is Our

Annual Mining Review

MINING CONGRESS JOURNAL is proud to bring to its readers this comprehensive summary of progress in the mineral industries. The authors who compiled these reviews are of the highest caliber—each eminently qualified in the field he has covered—and their combined efforts make it possible to obtain quickly an over-all view of the "state of the industry."

Although 1958 will be remembered as a "recession year," the articles herein strikingly demonstrate that it was also a year of far-reaching technical progress. Mining companies spent less money on new construction and fewer new mining projects were launched during 1958 than in the several preceding years. But operating progress forged ahead unabated, despite the need for stringent frugality. Perhaps this period of "belt tightening" has been a blessing in disguise. A certain amount of inefficiency always accompanies a period of rapid expansion, and the slowdown of the past year has given our industry a chance to "take inventory" of its methods and practices.

As you study the following reviews by our most accomplished technical leaders you will see that the mining industry remained wide-awake and did all within its power to alleviate its economic ills, increase its efficiency, and reduce its production costs.

Nonferrous Metals

None of the legislative or administrative measures suggested thus far will solve the basic problem of over-capacity or under-consumption of nonferrous metals. The only solution is for the industry and all its supporters to avidly promote increased use of copper, lead and zinc in all applications where their use is economically warranted

By SIMON D. STRAUSS
Vice President
American Smelting and Refining Co.

THREE factors account for the current depressed state of the nonferrous metal mining industry. These are:

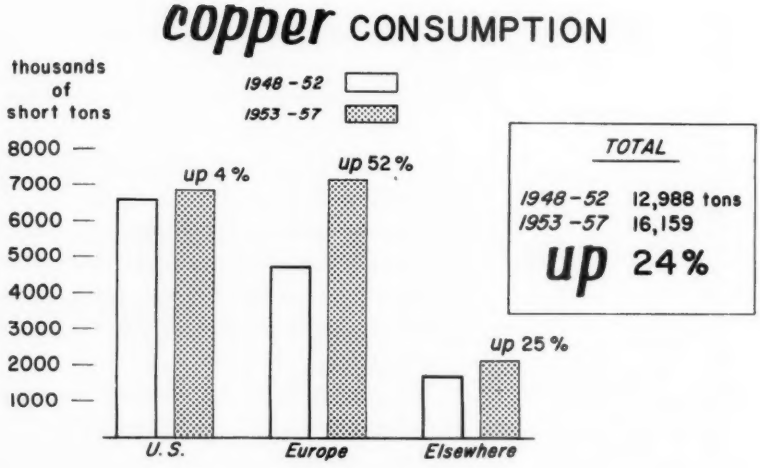
1. Geologists and mining engineers have been extraordinarily successful in finding new deposits of base metals in the period since the end of World War II in all parts of the world—including the United States.

2. The Korean War and the subsequent programs to stockpile strategic materials caused many of these newly developed deposits to be equipped for production more rapidly than would normally have been the case. Now that stockpiling is largely ended, this means temporary over-capacity.

3. Consumption of base metals in Europe and in certain of the newer industrialized countries has made substantial gains, but the use of copper, lead and zinc in the United States has grown more slowly than expected in the Paley report, issued six years ago by the President's Raw Materials Policy Commission.

Shortages Caused by War and Strikes Stimulate Expansion

When the Second World War ended it was quite the fashion to look on copper, lead and zinc as relatively rare materials which might soon be in permanently short supply as known deposits were exhausted. Certainly it is true that some day these irreplaceable materials will indeed become scarce. However, although the world outside the Russian sphere is annually using 3,500,000 tons of mined copper; almost 2,500,000 tons of mined zinc; and almost 2,000,000 tons of mined lead, it is also true that discoveries made in recent years have much more than replaced the quantities mined. Given economic incentive, the known favorable areas for exploration are

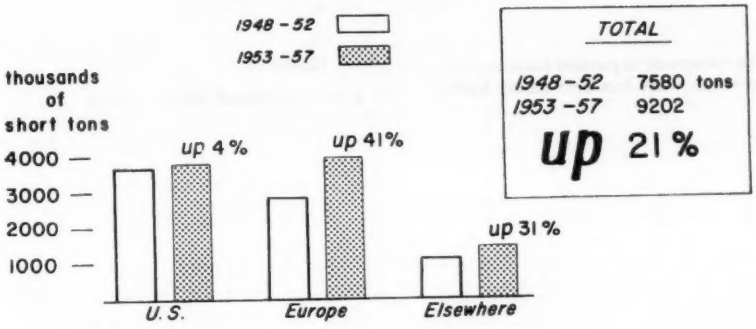


Yearly Consumption
(thousands of short tons)

Year	United States	Europe	Elsewhere	Total
1948	1344	840	291	2475
1949	1032	905	282	2219
1950	1372	955	305	2632
1951	1368	991	446	2805
1952	1446	1015	396	2857
1953	1444	970	331	2745
1954	1209	1414	395	3018
1955	1446	1558	437	3441
1956	1466	1562	465	3493
1957	1278	1657	527	3462
1958 (estimated)	1190	1750	550	3490

NOTE: All tonnages given in the chart and table exclude countries of the Soviet bloc and deliveries to U. S. stockpiles. Source: *American Bureau of Metal Statistics Yearbook.*

lead CONSUMPTION

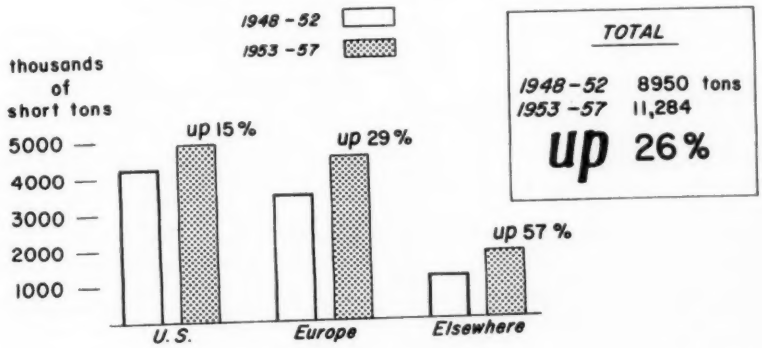


Yearly Consumption
(thousands of short tons)

Year	United States	Europe	Elsewhere	Total
1948	744	448	193	1385
1949	579	525	191	1295
1950	885	611	247	1743
1951	678	677	268	1623
1952	782	559	193	1534
1953	784	668	226	1678
1954	764	803	282	1849
1955	810	853	280	1943
1956	743	809	303	1855
1957	703	837	337	1877
1958 (estimated)	700	825	325	1850

NOTE: All tonnages given in the chart and table exclude countries of the Soviet bloc and deliveries to U. S. stockpiles. Source: *American Bureau of Metal Statistics Yearbook.*

zinc CONSUMPTION



Yearly Consumption
(thousands of short tons)

Year	United States	Europe	Elsewhere	Total
1948	818	632	191	1641
1949	712	656	173	1541
1950	987	718	251	1936
1951	934	774	284	1992
1952	853	721	266	1840
1953	986	709	289	1984
1954	886	946	336	2168
1955	1120	966	386	2472
1956	1009	917	396	2322
1957	924	994	420	2338
1958 (estimated)	900	1025	435	2360

NOTE: All tonnages given in the chart and table exclude countries of the Soviet bloc and deliveries to U. S. stockpiles. Source: *American Bureau of Metal Statistics Yearbook.*

such that even a layman need feel no hesitation in predicting that the rate of discovery could, if necessary, be materially expanded. There is no prospect of a genuine shortage of these metals for many years to come.

This fact was less clearly apparent at the time of the Korean War than it is now because that affair began less than five years after World War II had ended. Prospecting had virtually ceased during the World War, and although exploration work was actively resumed in the late forties, many of the discoveries of that period had not been sufficiently explored by 1950 to warrant equipment for production. Thus during Korea the governments of Washington, in London, and in other capitals of the Western World became panicky over base-metals supply.

It was in this period that numerous government contracts were made to expand production — in many cases from marginal deposits. By the time the mines had been opened and the plants built, the Korean affair was over. The new capacity was too late to help in the actual fighting; much of the material produced from this capacity moved directly into government stockpiles. Still later, the United States Government bought large amounts of lead and zinc as an alternative to increasing import duties. This sustained metal prices at reasonably satisfactory levels, but it also encouraged further expansion of capacity and continued prospecting and discovery.

In the case of copper, a period of labor difficulties during 1954 and 1955 in three of the five principal copper producing countries caused an artificial shortage which forced prices sharply upward. The abnormal prices stimulated new production and to a certain extent discouraged consumption.

Simon D. Strauss, an Asarco director since 1953, is well known as an authority on metals. He was born in Lima, Peru, and attended school in Chile before his family moved to New York in 1921. At the age of 16, he left City College to become an assistant editor of "Engineering & Mining Journal," where he remained until 1932. He then spent two years as editor of a newspaper in Madison, N. J.

During World War II, Strauss became a vice president of Metals Reserve Co., a subsidiary of Reconstruction Finance Corp. The MRC was responsible for contracts to supply strategic foreign metals for the United States. He joined Asarco in 1946, becoming sales manager in 1947 and vice president in charge of sales in 1949.

Simon Strauss now serves as president of the American Zinc Institute and is active in many other business and economic organizations.

Foreign Consumption Increases Faster Than Domestic

If one looks at the last decade for which complete statistics are available (the years 1948 to 1957), it is evident that world consumption of these metals (excluding, of course, deliveries to stockpiles) is increasing. The increase is irregular—like most economic movements it is subject to periodic interruption caused by business slumps, strikes, and similar factors. However, over a period of time these difficulties have a habit of evening out. If one takes the first five years of the decade, 1948-52, and compares them with the second five years, 1953-57, then consumption outside the Russian orbit has increased by 24 percent for copper; 21 percent for lead; and 26 percent for zinc. This is a satisfactory rate of growth.

But if the figures are analyzed by consuming areas, an interesting discrepancy appears. Consumption in Western Europe was greater in the second five-year period than in the first by 50 percent in copper; 45 percent in lead; and 32 percent in zinc. Elsewhere in the Western World—that is in Canada, Latin America, Japan, India, Australia and the underdeveloped countries of the Western orbit—the second five-year period saw gains of 25 percent in copper; 31 percent in lead; and 57 percent in zinc.

The United States during the mid-fifties was setting new records for industrial production and enjoying spectacular prosperity, but its use of base metals showed relatively minor gains—four percent each for copper and lead, 15 percent for zinc. Although in 1950 this country alone accounted for half the copper, lead and zinc consumed by the Western World, by 1957 our consumption was less than 40 percent of the total.

During the first half of 1958 there was a pronounced drop in consumption in the United States. Beginning in the third quarter, however, a modest recovery set in—reflecting improved prospects for the steel, automobile, and electrical appliance industries and continued high activity in construction. For the year as a whole, therefore, the use of copper, lead and zinc in this country was only slightly less than in 1957. Outside the United States the first half of the year saw further gains in metal consumption in a number of countries, but the pace slackened during the second half. Renewed labor difficulties in the copper industry in Rhodesia and Canada caused some speculative buying and encouraged consumers to rebuild depleted inventories. On the whole, in terms of metal consumption, 1958 is likely to be remembered as a year of only modest changes.

Earlier the author pointed out that the nonferrous industry is in trouble because too much ore has been found, too much capacity has been built, and too little metal is being used. Obviously, we cannot lose the mines already found—and would not want to if we could. It would be difficult to convince the owners of expanded plant capacity to scrap what has been newly built—and very wasteful and costly, too. There remains the third factor—consumption. About this something can be done.

In all probability consumption, in the normal cause of time, will catch up with excess capacity, and thus the deposits the geologists and mining engineers have developed will be put to effective use. If consumption of copper, lead and zinc over the next five years shows as great a gain as the last five have shown over the preceding period, then total consumption in the years 1958-62 would be 20,000,000 tons of copper; 11,150,000 tons of lead; and 14,200,000 tons of zinc. This would mean an annual average of 4,000,000 tons of copper; 2,240,000 tons of lead; and 2,850,000 tons of zinc. If the consumption of the Western World actually reaches these levels, the present problems of surpluses will disappear. In fact, the further expansion of productive capacity in copper, which is now underway, would likewise be readily absorbed.

In other words, if we can make as much progress in the next five years as we have made in the last five years, the outlook is good. But how good is this assumption?

If the most highly industrialized country in the world, the United States, shows only a low rate of increase in the use of copper, lead and zinc, is there not a danger that a similar trend may develop elsewhere? It is in this country that competition among raw materials is keenest; it is in this country that aluminum, plastics, stainless steel, and similar "growth" commodities have made the greatest inroads into certain of the markets for copper, lead and zinc. As other countries imitate the United States' industrial practices, they also may turn to competitive products.

This is a real danger. This industry should be genuinely concerned. It should make every effort to regain ground lost here in the United States—the industrial show case of the world.

Among many domestic producers the feeling has been strong in recent years that their problems should be solved by political action—tariffs, subsidies, import quotas, or stockpiling. Others have felt that governmental intervention is unwise and can only lead in the long run to the stifling of private enterprise. Regardless of these differing views, most producers almost certainly agree that the basic problem is one of over-capacity or under-consumption of the metals. None of the legislative or administrative measures suggested will solve this basic problem of imbalance between supply and demand.

Must Promote Greater Use of Nonferrous Metals

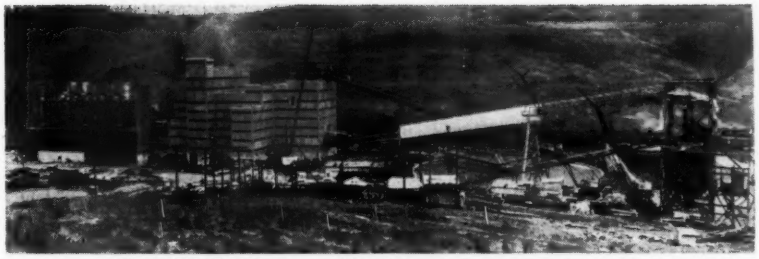
A greatly increased effort is being made now, through the trade associations, to promote existing uses for lead and zinc and to develop new ones. In this program every domestic producer of refined lead and slab zinc is enlisted. In addition, all the producers of Canada, Mexico, Australia, Peru and Great Britain have enrolled to bear their full pro-rata share of the cost. A similar program is now under discussion by the copper producers.

In these endeavors the governments of the Western States and the state mining associations of the West can be of tremendous assistance. For years now they have been diverting their energies and talents to the political scene. If some of this time and effort could be directed to the simple question of specifications for building materials, much good might result. For example, in 1956, the seven mining states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico and Utah spent $206,000,000 on state building projects alone. This figure is exclusive of expenditures by municipal, county or federal governments.

How many of these states require, as examples, that red lead be used in protecting steel surfaces, that culverts be of heavily galvanized steel, that building hardware be of brass or bronze? The author has not been able to ascertain that there is preference expressed for these products of local mining in any of these states—or indeed that the matter has been given consideration.

It would be unwise to use copper, lead and zinc where other products can do the job conspicuously better or conspicuously cheaper. That is not suggested. But what is feasible and desirable is that where the cost and the performance are comparable, the product with copper, lead or zinc be given the preference in mining communities.

The long-term trend of metal consumption will be determined by the people who decide which metal to use and how to use it. It is to them that our industry needs to tell its story. Where better to start than here in the West, where mining has long been a basic industry and where reception should be favorable. The qualities of copper, lead and zinc have been tested by time. There is no substitute for this experience. If we tell our story well and to the right people, then perhaps we need be less concerned with tariffs, subsidies, international agreements, buffer stocks, and all other expedients suggested for coping with economic difficulties.



About 400,000,000 tons of bituminous coal were mined in 1958

By GEORGE A. LAMB
Manager—Business Surveys
and
DON GASPER
Business Analyst
Consolidation Coal Co.

Bituminous Coal and Coal Economics

Despite a 15 percent drop in market requirements, the bituminous coal industry faces the new year with confidence because of improved productivity, favorable transportation developments and a united front in the problem of competitive fuels and other industry-wide problems

BITUMINOUS coal consumption and exports in 1958 totalled 420,000,000 tons compared to 490,000,000 in 1957, a drop of approximately 15 percent. Because of a decline in consumer stocks and after making allowances for coal in transit, 1958 production was 400,000,000 tons.

A world-wide business recession, dumped gas, depressed prices for imported Bunker C fuel oil, and an unusual year for hydro-electric power all combined to contribute to this market decline for bituminous coal. The steel industry had one of its worst years in two decades. Although total marketed production of natural gas increased only slightly over 1957, and the total demand for residual fuel declined, their burn in 1958 was much greater in those markets where they are actively competitive with coal. Much of the increase in hydro was strategically located in coal's principal marketing areas. Embargoes of coal imports by foreign countries added to the coal industry's woes.

Although these unfavorable developments made the industry wince a little, it survived the year with more than just hopes for a better future. New mines, improved productivity, favorable transportation developments and a united front in the problem of competitive fuels and other industry-wide problems strengthened bituminous coal for these better days. A new labor contract negotiated at the end of 1958 will assure the industry of its ninth consecutive year without a major labor disturbance.

Coke and Steel Slump

Steel ingot production during 1958 amounted to 85,000,000 tons compared to 113,000,000 in 1957. Based upon the percent of capacity ratio, the year will be the lowest in the last 20 years —60 percent. In 1949, however, the industry operated at 81 percent of capacity, but had a smaller output—78,000,000 tons.

During the first ten months of 1958, finished steel shipments were approximately 30 percent lower than a year earlier. Almost every market for steel products receded from the previous year, but two of the steel's largest customers were considerably below the average for all other products. Finished steel shipments to the automobile industry were down 35 percent, and deliveries to the oil and gas industry were 50 percent under 1957. With these two consumer groups representing 40 percent of the finished steel market, any changes in their purchases are bound to affect the industry's operations.

Although a decline in steel activity was anticipated for 1958, the magnitude was unexpected. Because of the sharp cut backs in steel operations, by-product coal was the hardest hit of all markets for bituminous coal in the United States. Metallurgical coal charged in by-product and beehive coke ovens during 1958 was 77,000,000 tons, a decline of 31,000,000 tons or 29 percent below 1957. Coal's total non-metallurgical market in the United States, however, was off 13,000,000 tons or four percent.

In addition to coking coal, the steel industry used 7,000,000 tons of bituminous for steam purposes. The steel and coke industry, therefore, consumed a total of 84,000,000 tons in 1958, compared to 115,000,000 in 1957.

Competition for Utility Fuel Business

Except for 1946, when the United States was retooling for a peacetime economy, 1958 was the least favorable year experienced for electric utility growth since the 1930's. The decline in total generation centered in the first half of 1958, was more severe

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George A. Lamb and Donald Gasper, in a joint effort, have presented Journal readers with a keen analysis of the bituminous coal picture in 1958.

Lamb has been manager of business surveys for Consolidation Coal Co. since 1946 and has followed closely the basic shift in coal markets that the United States has experienced since World War II. He has been a member of various coal industry committees and served as consultant to the Cabinet Energy Committee in 1954.

A graduate of the School of Mineral Industries, Pennsylvania State University, Gasper has been with Consol since 1951 and has served as a member of various committees within the coal industry.

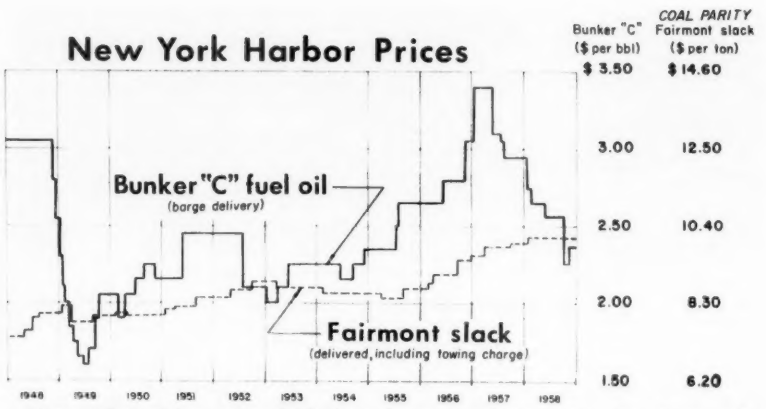
G. A. Lamb

D. Gasper

BITUMINOUS COAL CONSUMPTION AND EXPORTS
1957 and 1958

	1958	1957
	(Million Tons)	
Electric Utilities	152	157
Coke Plants	77	108
Railroads	4	8
Other Industrial	101	105
Total Industrial	334	378
Retail Deliveries	35	36
Total U. S. Consumption	370	414
Exports to Canada	13	18
Overseas Exports	38	58
Total Exports	51	76
Total Consumption and Exports	420	490

Source: U. S. Bureau of Mines



Residual fuel oil has comparatively little storage in relation to its sales volume and a relatively small excess or shortage can be highly disturbing to its price structure. Its prices have therefore fluctuated widely. The above chart shows that since 1948 the range between the lowest and the highest prices on residual delivered in New York Harbor has been $8.00 per ton in coal equivalent

than in any of the previous post-war recessions. In the third quarter electric power output began to exceed year-ago levels, and by December new records for generation were being made. Due to the rapid recovery in the second half of the year, 1958 electric power production did manage to exceed 1957 by about two percent.

Electric utilities consumed 152,000,000 tons of bituminous coal in 1958, down 4,000,000 tons from 1957. Part of the decrease in coal burn can be attributed to the sharp drop of power sales in numerous industrial areas. Utilities in the automobile-oriented economy of Michigan, for example, were unable to match 1957 generation until well into the third quarter of the year. Most of the state's utility industry is coal fired. Sales to steel mills and steel fabricating plants in other states, such as Pennsylvania, Ohio and western New York, were adversely affected by greatly suspended operations.

Reduced industrial activity tells only part of the coal's history in 1958. At least half of the decline in coal burn can be attributed to three competitive agents—hydro electric power, off-season or dumped gas and imported residual oil sold at depressed prices.

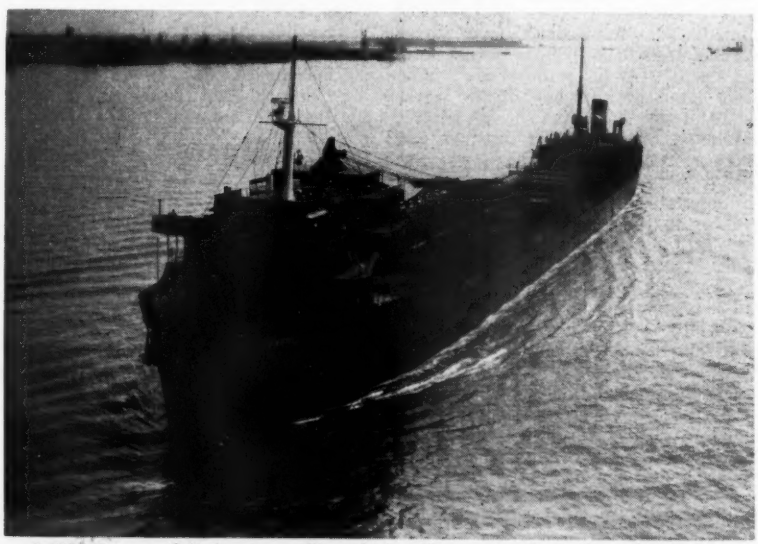
During the first nine months of 1958 hydro electric output was 12 percent over 1957, while generation by fuel burning plants was down two percent. The increase by hydro power in the Middle Atlantic states, alone, was comparable to about 500,000 tons of coal equivalent. Not only was the water supply most favorable for hydro, but the first units associated with the St. Lawrence Seaway began transmitting power to American and Canadian markets.

Imported residual oil is sold almost entirely on the Eastern Seaboard, a traditional coal market. The world market for this heavy fuel oil had softened since a number of foreign countries also had business recessions. An excess supply steadily developed and the foreign refineries turned to the United States for new outlets, promoting sales by cutting prices.

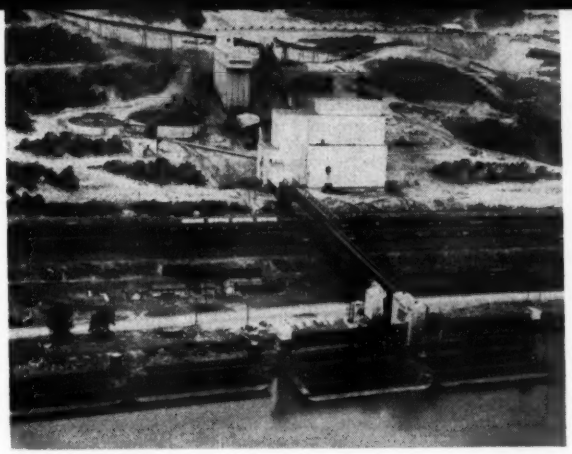
The price on residual oil for barge delivery in New York Harbor, which in 1957 averaged $3.12 per bbl ($13.00 per ton in coal equivalent), had a series of reductions in 1958, dropping by late summer to a low of $2.29 ($9.60 per ton in coal equivalent). Residual delivered directly by tanker sold at 15 to 20 cents per bbl under barge quotations, with a number of distress cargos dumped at even lower prices. While the barge price of $2.29 per bbl was about 50 cents below coal parity, the tanker and distress quotations reduced residual oil prices another 50 cents to a dollar below the delivered price of coal. Because of these depressed prices, Bunker C oil increased as a utility fuel along the Middle Atlantic Seaboard, while the total demand was down from 1957.

Residual fuel oil has comparatively little storage in relation to its sales volume and a relatively small excess or shortage can be highly disturbing to its price structure. Its prices have fluctuated widely. For example, since 1948 the range between the lowest and the highest prices on residual delivered in New York Harbor has been $8.00 per ton in coal equivalent. American refineries, in view of the slumping 1958 fuel market, reduced their output of residual oil substantially, but still not enough to offset the high level of residual imports that caused excesses and resulted in dumped prices.

In 1955 the Cabinet Committee on Energy Supplies and Resources Policy recommended that voluntary quotas be placed on both crude and residual oil imports. It held that if the imports of crude and residual exceeded significantly the respective proportions that the imports of crude and



A 24,000-ton self-discharging collier which will operate along the Atlantic Seaboard. Her automatic equipment will eliminate the need for any onshore unloading facilities



In August the Federal transportation tax of four cents a ton on coal was abolished. It is estimated that bituminous customers paid approximately $250,000,000 on this tax since it was first enacted in December 1942

residual bore to the production of domestic crude oil in 1954, the domestic fuels situation would be impaired and national defense weakened. The Cabinet Committee recommendation was followed in principle as far as imported crude oil was concerned, with a voluntary quota plan in effect during 1958. Nothing was done about a quota on residual imports.

Total marketed production of natural gas in the United States during the first six months of 1958 experienced a small decrease according to the U. S. Bureau of Mines. Yet, during the same period, gas under boilers in the country as a whole increased about three percent over 1957, and in the East natural gas consumed by electric utilities increased by 75 percent. This latter increase reflects a coal equivalent of another half million tons.

Natural gas has been continually expanding its market. In certain areas, gas is marketed only for superior uses, such as for residential and special industrial uses. During the off-season—the warmer months—when sales decline, gas is put into storage. In other areas, during the off-season gas is burned under industrial boilers, an inferior use, to keep pipelines operating at near capacity because storage has not been developed. This off-season industrial gas is generally sold at relatively low prices and displaces considerable volumes of coal.

The Cabinet Committee in its 1955 findings stated that natural gas sales, either for resale or direct consumption, below actual cost, plus a fair proportion of fixed charges, which drive out competing fuels constitute unfair competition and are inimical to a sound fuels economy. The committee recommended that appropriate action should be taken to prohibit these sales.

Other Industrial

Consumption of bituminous coal by general industry remained fairly constant, declining only four percent below 1957. One of the reasons this market showed signs of stability can be attributed to the strength of the non-durable goods industries (foods, textiles, paper, etc.) which did not decline at the same rate as the durable and capital goods segments of the economy. The "other industrial" category also includes government agencies and public institutions which buy coal in carload volume and are somewhat immune to wide business fluctuations.

From their peaks in 1957, durable goods dropped 20 percent, while non-durable goods declined only six percent. Furthermore, during the last half of 1958, this latter group maintained a rate of operation that surpassed the 1957 peak and continued to rise and establish new records. With this sustained activity, these industries were not only able to maintain, but managed to expand their requirements for fuel and power.

Not all durable goods declined. Cement mills, for example, continued to operate at a steady pace throughout the year because highway and building construction were maintained. The cement industry burned about the same amount of coal in 1958 and 1957.

Railroad Business Disappears—Retail Volume Holds

Coal burned by railroads dropped from 8,000,000 to 4,000,000 tons between 1957 to 1958. Steam locomotives are almost non-existent and what market remains is principally for powerhouse and station use.

Shipments to retail dealers had not changed materially during 1958. Better market conditions in some areas due to a colder heating season was offset by conversions to competitive fuels. Deliveries to retail dealers were 35,000,000 tons in 1958 and 36,000,000 in 1957.

Exports

Canadian imports of bituminous from the United States were 13,000,000 tons in 1958, compared to 18,000,000 in 1957. This was attributed to the general business recession, a lengthy strike in the steel industry and a drastic reduction in stocks of railroad fuel.

American exports overseas were approximately 38,000,000 tons in 1958 and 58,000,000 in 1957. Overseas exports to individual countries, however, did not follow any definite pattern. For example, the United Kingdom imported nearly 2,000,000 tons of American bituminous in 1957; in 1958 these imports almost disappeared. Belgium and Luxembourg continued their 1957 import schedule throughout most of the year.

Industrial activity in Western Europe, which boomed between 1954 and 1957, had a slow-up in 1958. The drop in fuel needs resulting from the industrial dip was accentuated by a mild winter and a drop in the tonnage of coal used for heating. With the European mining rate being maintained, coal was in abundant supply and the need for imports diminished. American exports to Western Europe in 1958 continued as high as they did because of long term commitments previously made, and their volume helped swell coal stockpiles that already were of record proportions at the start of 1958. Until these stockpiles are lowered considerably, Western Europe will want to import only special grades of coal.

Late in the summer, embargoes were placed in certain countries of Western Europe on coal imports to be bought in the future. They do not apply on shipments already under contract which include the bulk of the shipments to Europe. This action was followed by an announcement that the European Coal and Steel Community wanted to have its existing American coal contracts modified so as to reduce tonnage volume. The six nations of the Community buy over 80 percent of the American coal exports moved to Europe and, if efforts are successful in cutting imports, the American overseas movement will have substantial shrinkage in 1959.

During 1958, two groups were organized in the United States to promote sale of coal for export. These groups were the Low Volatile Coal Exports, Inc. and The High Volatile Coal Export Association, Inc. They were formed under the provisions of the Federal Export Act (Webb-Pomerene Law).

Labor

Walsh-Healey Act. Early in 1958, hearings were held for the redetermination of minimum wages in the bituminous coal industry under provisions of the Walsh-Healey Act. Originally minimum wages were established by the Secretary of Labor after extensive hearings held in 1955. The minimum wage applies to all contracts exceeding $10,000 on coal purchased by the Federal Government. In September the Secretary of Labor issued a final order, effective October 20, 1958, establishing a 50 cent an hour increase in minimum wages for

(Continued on page 43)

UNDERGROUND MINING PROGRESS

By C. KREMER BAIN
Consulting Engineer

THE year 1958 will be recorded as a very difficult period for the mining industry. Lower market prices and increased labor costs seriously reduced operating schedules. Carrying fixed charges with a lower tonnage presented a problem of how to make a small margin of profit, and in some cases, how to break even.

The outstanding achievement in underground mining during 1958 was the way management met this problem to stay alive.

Detailed analyses and re-appraisals of operations were made in an effort to save pennies—even mills—wherever possible. Equipment which had been purchased during the period of high metal prices to help offset spiraling labor costs and lower efficiency was analyzed by studying past performance data to determine how to increase its efficiency. Higher production per unit, greater availability and lower maintenance costs were the foremost objectives. Many more companies became conscious of the necessity of a good preventive maintenance program.

Development of New Mining Properties

The economic "squeeze" felt by operators made any outstanding changes in equipment or new developments few and far between. Interest in developing new mines, as well as re-equipping and modernizing existing mines, was almost nil. There were, however, a few notable exceptions as described below:

St. Joseph Lead Co.: The first of three production shafts was completed and further development was started at St. Joseph Lead's "new" Lead Belt near Viburnum, Mo. The second production shaft is ready to be collared and will be completed next year. This new property has all the indications of being the most important discovery of lead-bearing ore that has been made in recent years. Present plans call for a central mill, new townsite, and all of the facilities necessary for a large operation in what was heretofore an isolated area.

The Meramec Mining Co.: Development of the Pea Ridge iron deposit near Sullivan, Mo., calls for two shafts, each 3000 ft in depth, located approximately 900 to 1000 ft on the footwall side of large deposit of magnetite. Meramec, jointly owned by St. Joseph Lead and Bethlehem Steel Corp., plans an exploration level at about 1700-ft depth (some 800 ft below sea level) to definitely locate the foot and hanging walls and outline the ore body. This level will also provide locations for underground diamond drilling to furnish data on geological structure below this horizon.

The first shaft has traversed the entire strata of sediments, and with the exception of the Davis Shale and a portion of the Bonne Terre, water was encountered in various amounts. Flow had to be reduced by grouting before the water could be contained behind the circular concrete lining.

Chemical grout was used successfully to penetrate the LaMotte sandstone. This porous aquifer had previously proven to be impossible to seal with ordinary grouting procedure. Approximately 900 gpm at 300 psi was encountered from prospect holes at the bottom of the shaft. Chemical grout decreased the flow to 100 gpm with greatly reduced pressure, making it possible to seal off the water behind the concrete lining.

Potash Company of America: Canada's first potash mine went into production in November. It is located 16 miles east of Saskatoon, Saskatchewan. PCA began mining and milling following the completion of a 16-ft, circular, concrete lined shaft to the 3450-ft level. Sinking took place through ground that had been previously frozen throughout the entire depth. It is believed to be the deepest shaft put down in this continent through pre-frozen ground.

Continuous mining machines, designed and developed by the company, will be used; and the broken ore will be conveyed by a series of belts to storage bins near the shaft.

International Minerals & Chemical Co.: An 18-ft shaft is being put down by IMC near Esterhazy, Saskatchewan. It is also a concrete-lined circular shaft. In this case, only the first 320 ft through glacial till was frozen. Stage grouting, with a combination of cement grout followed by chemical grouting, is presently being used in the lower portion of the shaft.

Ambrosia Lake District: The only mining activity of boom proportions during 1958 took place in the Ambrosia Lake District of New Mexico. The high level of activity is indicated by the facts that 12 different companies have 14 operating mines, five properties are under development and two shafts are being sunk in this district.

The "dry" mines, which are relatively few in number do not present more than ordinary mining problems; but the so-called "wet" mines present interesting and difficult problems.

There is a wide variety of opinions on how to develop and mine Ambrosia Lake uranium deposits. This district is a veritable laboratory for experimentation on a production basis. Operators use all the types of equipment that are on the market, as well as older machines which have been altered, to meet the adverse conditions.

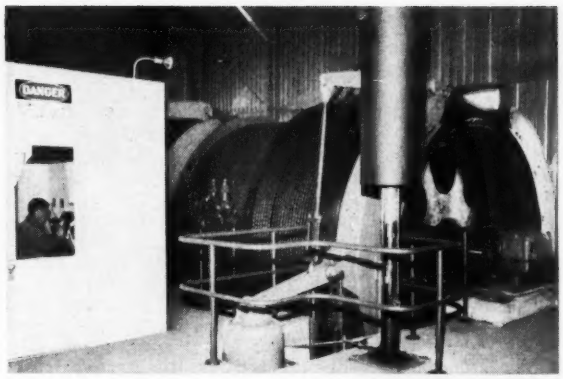
Standard front end loaders and diesel powered trucks predominate at the present time, but with so much talent, both among the operating staffs and the equipment manufacturers, it can be assumed that new machines will be developed for the special conditions of this district.

There have been some very good articles written about this district, and before the mines are fully developed the writer is quite sure there will be many more, because the district as a whole is a challenge for free use of ingenuity and resourcefulness.

Drilling

The amount of drilling by air legs is still small percentagewise. There

Increased use of concrete underground continued in 1958. San Manuel Copper Corp. reports significant advantages from the use of Flocrete Placers on wheels, or "pots" as they are called. Cost per cu yd of concrete placed has been reduced more than 25 percent compared with the old method which used stationary pneumatic placers



Tennessee Copper Co. equipped its shaft with a unique counterbalancing arrangement for hoisting ore. A 1000-ft capacity, single drum hoist was installed which has a 12.5-ft diam counterweight side and a 13.0-ft diam skip side. This permits cutting the ropes off at various intervals without having to carefully balance rope lengths

is a trend in this direction where ground conditions and rock hardness permit and short holes are required. The length of hole drilled has increased on the average, and there seems to be a definite division between air legs for relatively short rounds and jumbos for long rounds.

There is a definite trend toward smaller gauge bits with smaller machines—even on jumbo drilling.

In tunnel contracts there is a trend toward large machines (5½-in.) for drilling five to seven-in. holes to replace the burn; but in the average underground mine the burn cut still predominates.

There has been little change in the standard percussion-type drill. One company reports experimentation rents preclude use of electric caps. with a special chuck designed to use six-in. shanks instead of the standard 4¼-in. Preliminary results are encouraging.

Underground drilling practice was covered in a paper presented by Raymond Stewart at the September meeting of American Mining Congress. The report summarizes the answers obtained from questionnaires sent to 60 mining companies, and gives a comprehensive picture of drilling that is interesting and well worth studying. It is scheduled for publication in an early issue of *Mining Congress Journal*.

Other sources of information indicate the following trends:

1. In Canada, the trend is definitely toward tapered socket removable bits. In the United States, however, threaded bits are most frequently used.

2. The use of integral steel has receded somewhat in favor of multi-use bits—either the tapered socket or threaded removable type.

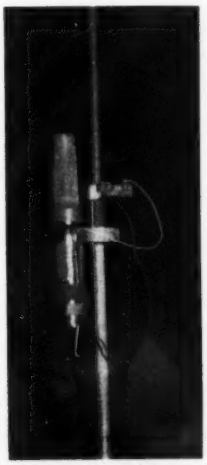
3. There seems to be a trend toward carburized steel. A number of companies have either eliminated their own sharpening shops or are giving it serious consideration.

4. There has been improvement in the quality of carbide inserts, and a concerted effort to produce alloy or carburized drill steels with increased life.

5. One company reports the experimental use of integral flexible drill steels in the undercut drifts for block caving. If successful, the company hopes it will eliminate the need for enlarging these drifts.

6. Rotary percussion drills are being developed which might fulfill the requirement for faster drilling speed sometime in the near future.

7. One report describes a down-the-hole drill being tried out experimentally for drilling nearly horizontal holes.



Rock mechanics instrumentation has proved effective in contracting pillar recovery operations and in warning of dangerous roof conditions. Shown is one of the devices used by St. Joseph Lead Company's mining research department for detecting ground movements. The instrument consists of a flashlight which is operated by a microswitch with a micrometer adjustment. This apparatus is hung on a spring loaded telescoping pipe which is placed at any desired location in the stope. Adjustments can be made so that a convergence of only one or two thousandths of an inch will turn on the light

Blasting

Mixtures of ammonium nitrate and diesel fuel oil, which have gained such wide use in open pit work, have not been used underground to any appreciable extent. However, there is a very wide field of thinking toward adapting this low-cost explosive to underground mining.

The Eagle-Picher Co. reported initial results which indicate underground ammonium nitrate blasting might be feasible in many situations. Others reported favorable experimental results, but they still had to work out details of packaging, storage and handling.

No doubt, explosive companies are working on an insensitive explosive to meet this apparent competition, and their facilities should provide advantages in packaging and waterproofing the cartridges.

Experimenting with changes in grade and velocity of standard brand explosives has improved fragmentation at several operations.

Tennessee Coal & Iron Co. reports deeper drill rounds and improved fragmentation have been achieved by using Primacord for simultaneous detonation of cut holes. Stray currents preclude use of electric caps.

Loading

There has been a definite trend toward front end loaders on tracks, because they are fairly selective and thus minimize dilution. Lately, there has been a marked, but not rapid swing toward substituting pneumatic tires on front end loaders in an effort to reduce maintenance cost.

A low height loading machine, designed to work in areas within minimum clearance, is now undergoing production tests.

Haulage

Diesel powered trucks are continuing to gain in popularity. They have definite advantages in widely disseminated, irregular ore bodies where the mining method requires extreme flexibility. Good roadways and adequate ventilation are essential for the successful application of this equipment.

U. S. Potash Co. reports the completion of about six miles of heavy duty macadam road for ore haulage between two of the company's shafts. Fifty-ton payload Kenworth diesel trucks are hauling the ore, and results are better than expected.

Extended use of belt haulage is quite in evidence, and conveying mine-run ore is not unusual. Wherever panel conveying and mainline haulage by rail are employed the following combinations are possible: (1) shuttle cars to main conveyor belts; (2) shuttle cars to cross belts to main conveyor belts, and (3) diesel trucks to both cross belts and mainline.

Potash Company of America reports the development of a shuttle-type conveyor, which has facilities somewhat similar to other shuttle and extensible conveyors, but has the additional advantages that it easily can be moved mechanically in sections up to 200-ft long, and there is no problem in moving it around corners with the belt in place.

Tennessee Coal & Iron Division, U. S. Steel Corp., reports 135-ton diesel shuttle cars have replaced older electric cable trailing shuttle cars. These cars are capable of operating

on steeper grades, and have eliminated the nuisance of trailing cables.

Four-wheel drive, four-wheel steer, electric shuttle cars, with two 40-ton drive motors were successfully used on 19-degree slopes in the Blind River District of Canada during the development stage and while ventilation was being established. Both diesel-powered shuttle cars and dump trucks are being used in this district wherever there is sufficient ventilation.

Hoisting

Reports from all Koeppe hoist installations state they are operating satisfactorily. There is a definite trend toward this type of installation. Automatic hoisting and skip loading are becoming more prevalent where the tonnage output and ore reserves warrant the initial installation costs.

The bottom dump skip is gaining favor over the Kimberly type skip.

Rope guides are employed in several shafts, and their use is being

Tennessee Copper Co. equipped its 2080-ft shaft with a unique counterbalancing arrangement for hoisting ore. A 1000-ft single drum hoist was installed which has a counterweight side that is 12.5 ft. in diameter and a skip drum portion 13.0 ft in diameter. This permits cutting the ropes off at various intervals without having to carefully balance rope lengths. Conductors in the core of the hoist rope for use in skip to hoist communications have proved satisfactory to date.

Ground Support

Rock bolting has established itself in practically every operation where stabilization of the ground is required.

Hydraulic filling has become standard practice at many operations which have adapted their mining techniques to realize its advantages.

The U. S. Bureau of Mines has compared the load bearing characteristics of hydraulically-placed sand with various dry-placed, sand-rock mixtures. The comparisons indicate a much higher compressive strength for the hydraulically placed sand. Up to 12 times as much pressure is required to compress hydraulic fill five percent in volume. The slime fraction must be removed from fill material so that the water will drain through the spaces between particles and the use of wet cyclones for this purpose has become quite popular. Minimum percolation rate is generally four in. per hr.

The use of concrete for support of scram drifts is increasing. A report from San Manuel Copper Corp. illustrates the progress that is being made in underground concreting:

"During the past year, San Manuel's concreting program accelerated considerably, because we improved our methods of mixing and placing concrete. Prior to this year we were using two stationary pneumatic placers. Now we are using Flocrete Placers on wheels, or 'pots', as we call them. Among the advantages of the pots over the stationary placers are: (1) less segregation and therefore better quality concrete; (2) easier to change pouring locations; (3) no stoppage due to plugged pipes between the placer and the forms, and (4) approximately three times as much concrete poured with the pots as with the placers per eight-hr shift. An average of 125 cu yd of concrete per shift is poured using the pots.

"With the use of the pots our total concreting costs per cu yd of concrete placed have been reduced more than 25 percent compared with the old placer method.

"Our use of concrete has resulted in reduction of drift repair, better ventilation and increased draw efficiency. Under the latter could be included: (1) cleaner grizzly drifts (no scrap or broken timber); (2) more working room for the men, and (3) fewer draw points closed down for repair.

"With relation to repair costs, we can say that our maintenance costs have been reduced by at least 70 percent in our panel fringe drifts and at least 90 percent in our grizzly drifts since we started using concrete underground.

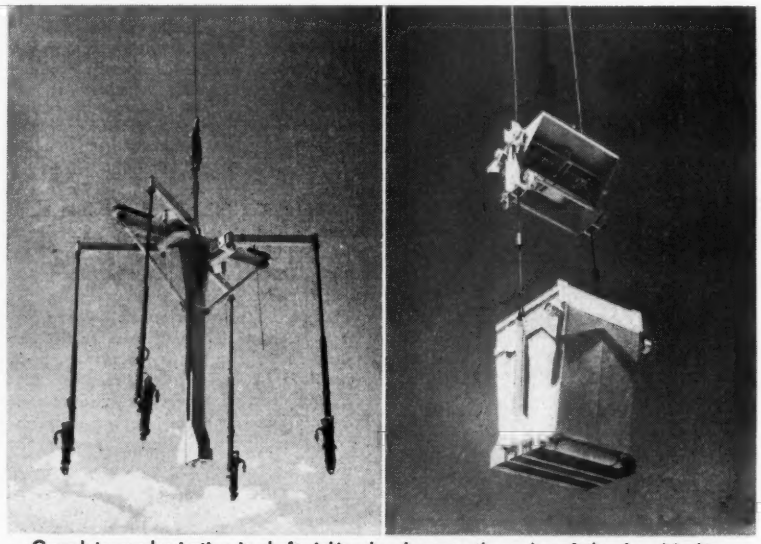
"We soon expect to be using jumbo-placed, prefabricated, circular steel forms in our fringe drifts in an effort to reduce forming costs and increase forming efficiency.

"Concrete, as we use it here, is proving its worth in every instance; therefore, the tendency is for its increased usage in all future operations.

"A program of grouting our haulage drifts has also been under way this year with the following results: (1) ground movement and timber breakage is retarded; (2) runs of loose muck are prevented during timber repair stages, and (3) overbreak is reduced when excavating for raise stations.

"Twenty-ft holes are first drilled in the back and sides, after which grout composed of cement, water, and bentonite is pumped into these holes. The grout cements and consolidates the loose broken ground in the back above the lagging and thereby the weight on posts and caps is distributed more evenly. The grout has increased the life of standard drift posts and caps by two or three times."

St. Joseph Lead reports that systematic mechanized roof bolting has been shown to be economically and technically effective for pillar removal in limited areas with spans up to about 100 ft. Rock mechanic instru-



Complete mechanization in shaft sinking has become the order of the day. Mucking machines have replaced hand labor, and jumbos have replaced handheld machines, except in small and relatively shallow shafts. High capacity materials handling equipment and methods have come into general use. Pictured are two pieces of equipment which exemplify this progress: A collapsible rib, umbrella type jumbo (LEFT), and a 70-cu ft safety sinking skip (RIGHT). The jumbo can be lowered to its working level through a 48-in. diam opening. Once in place, the arms are raised to the horizontal and four retractable air legs are put to work, one suspended from each arm. The skip is attached to two 30-ft, ¾-in. cables which pass through a standard crosshead and fasten to a bridle on the main hoisting cable. The crosshead is disengaged on reaching the lowest set of timber in the shaft and the skip can pass to the shaft bottom. During hoisting operations the crosshead and skip are locked together, and in the event of cable failure, dogs on the crosshead grip the timber guide rails and prevent the unit from falling

mentation is effective in contracting pillar recovery operations and warning of dangerous conditions.

Tennessee Coal & Iron reports that roof bolting machines with elevated platforms and Leyner drills mounted on a boom have replaced conventional machines equipped with stoper drills. Thus changing steel is eliminated and the amount of roof bolting accomplished per shift is increased. They have also substituted short channel sections for the long channels previously used in connection with roof bolts.

Shaft Sinking

Complete mechanization in shaft sinking has become the order of the day. Mucking machines have replaced hand labor, and jumbos have replaced hand-held machines (except in the small and relatively shallow shafts). High capacity materials handling equipment and methods have come into general use.

Although rectangular shafts are still being sunk, circular shafts are making inroads. At least the circular shaft is no longer an oddity, and those who have used it have been rewarded by cheaper initial cost and much lower maintenance.

The circular section lends itself to the use of blasting patterns designed to produce minimum overbreak. Of course, it's easier mucking too, because there are no corners to clean. There is no question that the concrete-lined shaft offers greater strength per unit of concrete placed, requires less labor for forming and alignment, and is more adaptable to grouting where it is necessary to seal off water to obtain a relatively dry shaft. Since the shaft itself requires no internal support, the only function of the steel set is to support the various runners, pipelines, ladders, etc. Consequently it can be a fairly light section and placed on 10-ft centers. The steel can be prefabricated so that it can be bolted to steel I beams or inserts which are cast into the concrete during original placement.

Where State mining laws permit, an open unobstructed shaft has the advantage of permitting longer rounds, because the ground can be drilled to the maximum depth that can be broken without fear that the blast will injure the shaft set. Placing steel in an open shaft consumes less over-all time because it can be carried on without interruption, and because the sets can be prefabricated on the surface, lowered, and bolted into place as a unit.

Steel sets can be carried down as the shaft progresses, and guides, platforms, ladders and pipelines installed to meet all requirements of the mining laws and the desires of the company. Service lines can be carried down in the concrete lining or attached to the shaft lining or steel sets.

In one instance, a 16-in. pipe imbedded in the concrete wall now serves as a ventilation pipe during sinking. This same pipe will serve to accommodate a counterweight for the cage when operations begin.

The Cryderman shaftmucker, a familiar piece of equipment in rectangular shafts, can be readily adapted to circular sections. The Eimco 630 has been used successfully in shafts large enough to permit its use. The clam shell has also proven to be very effective, using either the Riddell system or the Bain system with remote control.

The 16-ft shaft which Potash Company of America recently completed near Saskatchewan has no dividers. This arrangement was made possible by the use of rope guides suspended from the head frame. Each cage travels on two of these guides. The main shaft opening serves as an air exhaust, and fresh air is vented down the mine in an air duct made up of arc shaped panels of plastic treated fiberglas which form a lens shaped tube adjacent to the shaft walls. Several other companies are studying the use of rope guides.

Summing up the case for the circular shaft, M. A. Hanna Co. states: "We have had an excellent chance to compare costs between the circular shaft and the conventional shaft. All factors equal, we find that the circular shaft is considerably cheaper than the rectangular shaft. We feel our decision to build a circular shaft is justified by the fact that we have a stronger, drier shaft and one well suited to the intended type of hoisting. We are satisfied not only that it is cheaper to sink, but also that additional savings in decreased maintenance will be apparent after several years of operation."

BITUMINOUS COAL

(Continued from page 39)

every major coal producing district in the United States. In the Appalachian coal fields the current minimum becomes $2.745 an hour.

New Contract Signed. Early in December the operators and United Mine Workers of America signed a new wage agreement. The contract provides for a wage increase of $2.00 per day, $1.20 taking effect on January 1, 1959, and the remaining 80 cents applying on April 1, 1959. With the full $2.00 applying on the latter date, the basic inside day rate will amount to $24.25 in the Appalachian and certain other fields.

In addition to the wage change, the vacation payment is increased from $180 to $200 and a *Protective Wage Clause* is added. Under the Clause, the commercial operators agree not to mine, produce, prepare, procure or acquire, either as principal or agent, bituminous coal produced under terms and conditions less favorable than those in the contract. Furthermore, the commercial operators agree not to lease, license, or contract out on coal lands, producing or preparation facilities to avoid application of the contract.

Mine Employment and Productivity. Employment in the bituminous industry averaged 185,000 during the third quarter, and it should be near the year's average. This is the lowest annual employment since 1890.

Mine productivity continued to improve. Output per man-day, which was 10.6 tons in 1957, reached approximately 11 tons in 1958 according to preliminary data. Ninety percent of the output is mechanically loaded.

Transportation

The Interstate Commerce Commission granted the railroads authority to increase freight rates on bituminous coal, effective February 15, 1958. These increases varied between eight and ten cents a ton depending on whether all-rail or some method of water and rail transportation is involved. The freight rate on coal moving to tidewater for export was not changed.

In August the Federal transportation tax of four cents a ton on coal was abolished. It is estimated that bituminous customers paid approximately $250,000,000 on this tax since it was first enacted in December 1942.

During 1958 the railroads published numerous volume rates on bituminous coal. These rates were made applicable if rail movement exceeded a certain minimum tonnage per day, per week or in a previous year. The principle behind volume rates is to meet or beat competition. This competition may be between the railroads and competitive transportation or between coal and competitive fuels. In August the Pocahontas railroads published a rate reduction of 35 cents a ton to plants of the Virginia Electric Power Co., if the total coal movement exceeds 1,500,000 tons during a preceding 12 month period. Other volume rates were published, the most of which are on coal moving from the Midwestern coal fields to Illinois and Indiana destinations.

In August 1958 Consolidation Coal Co. announced that its 108-mile coal pipeline was in full operation. In a 30-day period the line had operated at an average rate of delivery exceeding its designed capacity.

In 1958 the first self-discharging super collier was christened at Newport News, Va. The collier, which will operate along the Atlantic Seaboard, has a capacity of 24,000 tons, twice that of conventional coal carriers. The vessel with her automatic equipment will eliminate the need for any onshore unloading facilities.

Iron Ore

By HERBERT C. JACKSON
A Managing Partner
Pickands Mather & Co.

Problem: steel industry faces increased demand, higher costs and greater competition

Required: more steel capacity without high capital investment

Solution: boost furnace efficiency by using high grade furnace feed from beneficiated ores

Note: increase imports of iron ore to supplement domestic production

IN any discussion of the iron ore industry today, it is important that we have in mind the revolutionary change in blast furnace operators' specifications for iron ore that has been taking place during the past decade, and is presently continuing at an accelerated pace. We should also have in mind the greatly increased iron ore tonnage requirements of the United States iron and steel industry which has occurred over the past 10 years and the continuing expansion of these requirements for the future.

Steel Industry Demanding High Grade Furnace Feed

Historically, our iron and steel industry was satisfied to accept the grade of natural ores available in the United States, 80 percent of which ores came from the Lake Superior District. This grade of iron ore averaged approximately 51 percent natural iron and there was no special attention paid to the physical characteristics of the ore. Under these conditions, when the iron and steel industry needed additional pig iron production, they built more blast furnace capacity.

This is not true today—the emphasis now is on obtaining maximum output from the existing blast furnaces in order to reduce costs and avoid a capital investment of approximately $60,000,000 for each new blast furnace and its related facilities. During the past few years it has been recognized that there is more than a proportionate increase in blast furnace yield when higher grades of iron ore of uniform structure are used as blast furnace feed. The result is that the iron and steel industry is now demanding from the producers of iron ore a high-grade product with improved physical characteristics.

To a considerable extent, the iron ore industry in the United States has been prepared to meet the requirement for improved quality. As long as 30 years ago, the large producers of iron ore, anticipating the exhaustion of the then considered high-grade natural ores in the United States, started experimental work to produce high-grade concentrates from hard, low-grade Minnesota taconites.

As a result of these experiments, Erie Mining Co., owned by Bethlehem, Youngstown Sheet and Tube Co., The Steel Company of Canada and Interlake Iron Corp., and managed by Pickands Mather & Co., in 1948 built a preliminary plant to determine the best method and the most economical process to produce a satisfactory iron ore product from this low-grade taconite. After several years of operation, and the production of over 1,000,000 tons of high-grade iron ore pellets averaging approximately 62 percent iron, the economic feasibility of producing this high-grade product was proven. During the same period, Reserve Mining Co., owned by Republic and Armco, and the Oliver Iron Mining Division of United States Steel Corp., also built pilot plants to study the production of high-grade taconite concentrates. As a result of these studies, Erie and Reserve have both

Few people have had experience in iron ore mining to compare with that of Herbert C. Jackson in his work for Pickands Mather & Co. After completing studies at Yale, Jackson joined the company in 1916, and became partner in 1942. In 1955 he was made a managing partner, the position he holds today. Jackson is a vice president of American Mining Congress, vice president and director of Interlake Steamship Co., chairman of the board and director of American Iron Ore Association, and a director of Lake Carriers Association.

built large-scale production plants, with a total annual capacity in excess of 12,000,000 tons of high-grade blast furnace feed. In Michigan, Cleveland-Cliffs Iron Co. has built two plants designed to produce high-grade iron ore from the Michigan jaspers, and The M. A. Hanna Co. is now building a plant in Michigan to treat jasper ores.

Throughout the country, experimental work on the beneficiation of iron ore has been progressing. In addition to the Minnesota taconites and the Michigan jaspers, considerable work has been done to up-grade the Alabama low-grade ores by iron and steel producers in the Birmingham district. In the west, Kaiser and Columbia-Geneva Steel Division, among others, have made a great deal of progress on beneficiation, blending and sintering of western ores. In the eastern states, beneficiation of Adirondack ores by Jones & Laughlin and Republic, and of Pennsylvania and New Jersey magnetites by Bethlehem, Alan Wood and others, have provided substantial tonnages of high-grade concentrates for these companies' furnaces. These efforts throughout the country by iron and steel companies, as well as iron ore producing companies, have substantially improved the techniques of iron ore beneficiation and agglomeration.

Initially the iron ore industry research was motivated by a desire to replace the production capacity which would be lost as natural ore reserves were exhausted. The industry sought to utilize the large quantities of low-grade ores available for concentration so that the United States could be kept self-sufficient in iron ore producing capacity. While this objective has been successful to an extent, an accompanying result has been that the high-grade product produced through research by the iron ore industry has alerted the iron and steel industry to the benefits in blast furnace production and costs by using these improved iron ore products. During the past few years, with the high-grade pellets, concentrates and sinter available from the iron ore industry's research efforts, the steel companies associated in these enterprises had the opportunity of running large-scale blast furnace tests on these improved raw materials. Also, during the last decade, there have become available large tonnages of high-grade direct shipping iron ore imported principally from Canada and South America. The results of the use of these products—pellets from the Lake Superior District, properly prepared high-grade foreign ores, high-grade concentrates from the eastern states, and beneficiated western ores; all of which have provided directly or by sintering, a more uniform furnace burden—demonstrated that not only was furnace productivity increased to the extent of the increased iron content of the burden, but that output was further increased due to improved physical characteristics of the furnace feed. The results of these tests led to the construction of the large-scale taconite plants and to the increased application of beneficiation of ores throughout the United States.

This, then, is the revolution in the iron ore industry which has been developing with increasing intensity annually over the past decade, and particularly in the last two years. It has become standard practice to require these improved, higher quality iron ores as raw material for the iron and steel industry.

Ore Imports and Steel Exports Rise

While this revolution was taking place, the tonnage requirements of the iron and steel industry have expanded greatly. Ten years ago, the iron and steel industry required approximately 107,000,000 gross tons of iron ore in order to provide raw materials for a steel capacity of something over 94,000,000 net tons. Ten years ago about 95 percent of the iron ore shipped to the United States iron and steel industry came from our country, and only five percent from foreign sources. In 1957 our iron and steel industry received 133,000,000 gross tons of iron ore, of which about 75 percent originated in the United States and 25 percent from foreign sources, primarily from Canada and Venezuela.

There has also been a significant shift in the proportions of iron ore produced in the United States from the Lake Superior District to the balance of the United States. Of the iron ore originating in the United States and shipped to the United States steel industry, 10 years ago about 85 percent came from the Lake Superior District and the balance from other districts in the United States. A similar distribution for 1957 shows that approximately 80 percent came from the Lake Superior District and 20 percent from the balance of the country. This shift amounted to a decrease of approximately 6,000,000 tons from what the Lake Superior shipments would have been if the ratio of a decade ago had still been maintained. Actually, the percentage of Lake Superior ores to the entire shipment in the United States might have been substantially less if it had not been for the foresight of the iron ore industry in locating large taconite and jasper concentrating plants in Minnesota and Michigan which made available a substantial tonnage of high-grade concentrates.

In connection with the greater imports of foreign ores into the United States and the shift of production in the United States from the Lake Superior District to the balance of the country, it should be borne in mind that a considerable portion of the increased capacity of the iron and steel industry in the past 10 years has taken place in locations beyond the normally accepted boundaries of the Lake Superior District market area. This expansion of the steel industry, particularly in the eastern and western areas of the United States, was motivated by the desire to be located in new and growing steel markets and to attempt to become competitive with foreign steel producers in foreign markets.

To give you an idea of the importance of these foreign markets, it is necessary only to indicate that the iron and steel products manufactured by the steel industry which were exported in 1957 had a value of $1.4 billion, and if you add to this the machinery and vehicles and other manufactured products which are largely made of steel, this total exceeds $7.5 billion. Compared to the value of the exports of iron and steel and products manufactured from iron and steel, the United States iron and steel industry's net import of foreign ores had an estimated value of only about $370,000,000. In other words, the value of these iron and steel products exported to foreign countries was 20 times greater than the value of the net imports of iron ore. A substantial portion of the value of the exported iron and steel material is a source of employment, wages and profits through all areas in the United States.

It must be recognized that the entire iron ore industry is dependent for its future on the success with which the iron and steel industry meets the competition of other steel producing countries throughout the world. Since the United States steel industry can get only a portion of its ore requirements from domestic sources, it needs the foreign ores to fill its present requirements and to supply ore for the future expansion of the steel industry.

Foreign Ores Needed to Supplement Domestic Production

For the past several years, an average of approximately 1¼ gross tons of iron ore were consumed by the iron and steel industry for every net ton of steel produced. Thus, at the present rated steel capacity of over 140,000,000 net tons, something in the neighborhood of 160,000,000 gross tons of iron ore production capacity is required. Estimates have been made which predict that 10 years from now, the steel industry will have a rated capacity of 175,000,000 net tons, which at present consumption rates would require close to 200,000,000 gross tons of iron ore. At the present time there is insufficient iron ore production capacity in the United States to supply our iron and steel industry at capacity operation for any sustained period, nor are there sufficient known reserves in the United States which can be economically and competitively developed to furnish the needed additional iron

ore to satisfy the steel industry's future iron ore requirements.

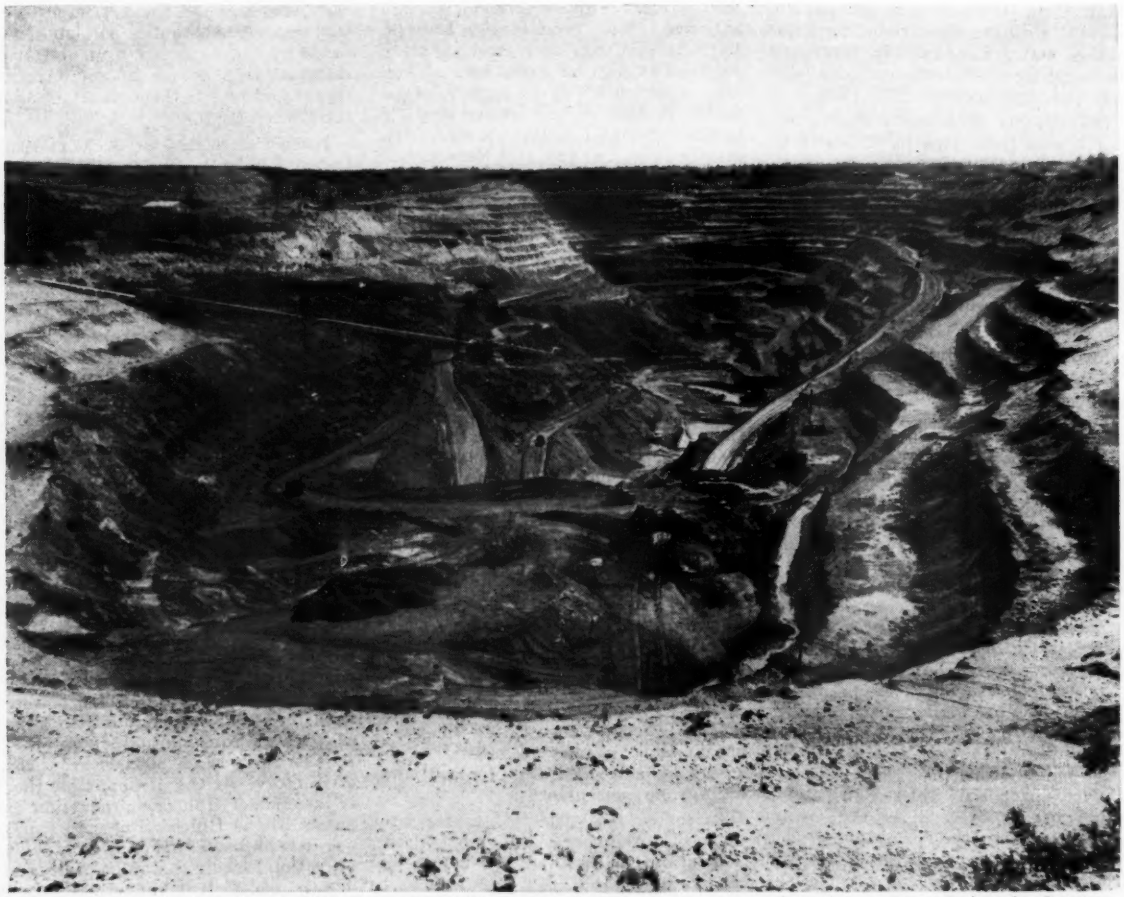
With the large present requirement of the steel industry for iron ore, and with the probable future expansion, foreign sources of iron ore are a necessary supplement to our domestic production.

In the future, we are likely to see the United States iron ore industry develop high-grade sources of iron ore, to a large extent high-grade concentrate products, both in the United States and Canada. Whether these developments take place through the expansion of present taconite concentrating plants, or through new construction in United States areas or elsewhere, will be controlled by the comparative amount of capital investment required to produce an annual ton of capacity and the ultimate cost per unit of iron at the point of consumption. Expansions and construction of concentrating plants for intermediate grade ores in the Lake Superior District may take place, provided proper tax treatment by local and state government can be assured on a long-term basis, before large capital investments for these purposes are made.

With regard to the position of the iron ore industry in 1958 it is obvious that because the United States iron and steel industry operated at an average rate of 60 percent of capacity, the requirement for iron ore was similarly reduced. Shipment of iron ore to United States consumers for 1958 was in the neighborhood of 90,000,000 gross tons. The domestic iron ore industry provided approximately 70 percent of these requirements, and foreign ores the balance of 30 percent.

Costs Must Be Minimized to Remain Competitive

To the extent available, the tonnages of iron ore that are being shipped are the high-grade ores and concentrates which are the result of the revolution in iron ore requirements to which we have referred. It is important that we recognize that the iron and steel industry, faced with rising labor costs, must produce its products as cheaply as possible to maintain its competitive position in this country against foreign imports of iron and steel products and its present large export position in foreign countries. This means that the iron and steel industry must utilize to the fullest extent their present blast furnace capacities in order to avoid large capital expenditures for new plants, and the maximum capacities of these furnaces can only be utilized if high-grade and properly prepared furnace feed is made available. The United States iron ore industry recognizes its obligation to provide desirable high-grade iron ore material and products that can be used directly by blast furnaces, or converted by sintering into acceptable high-grade furnace feed, and which can be manufactured into iron and steel products at the lowest possible cost. This will require the domestic iron ore industry to continue the research which it has been carrying on in iron ore beneficiation and agglomeration, and to locate the mining and concentrating operations where suitable iron-bearing material is available that can be converted to acceptable high-grade product and delivered to the consuming blast furnaces at a minimum cost per unit of iron.



Ten years ago the Lake Superior District produced 85 percent of the iron ore consumed in this country. Today the District accounts for 80 percent. Pictured is the huge Embarrass pit of Pickands Mather & Co., which is located on the eastern end of the Mesabi Range

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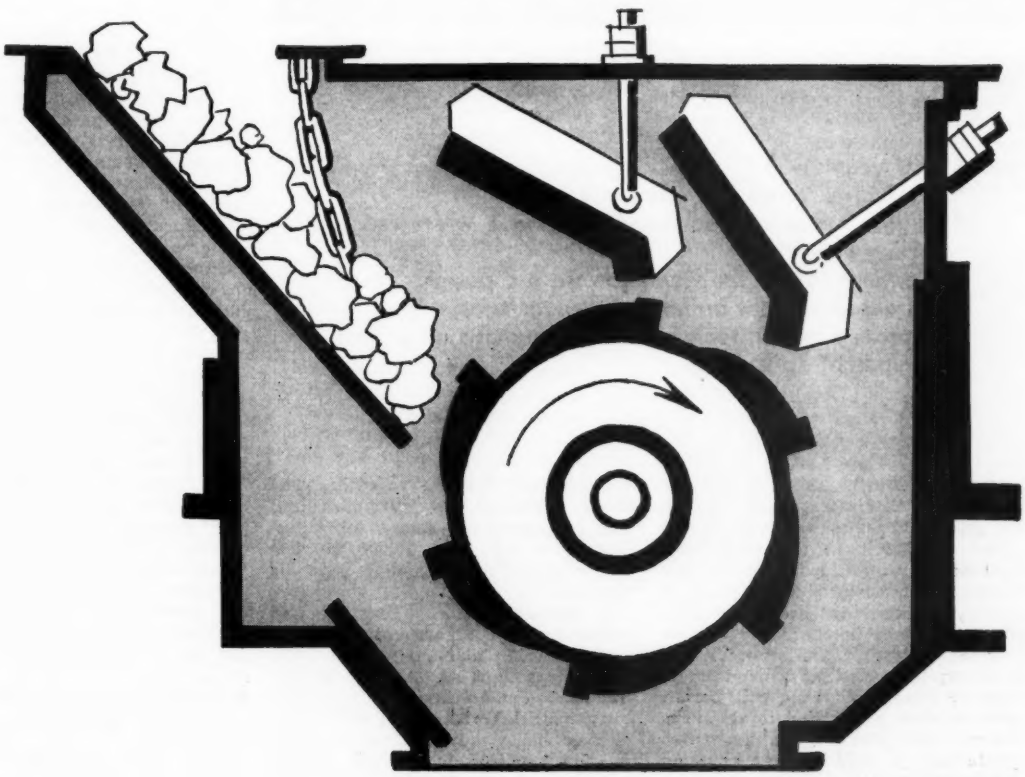
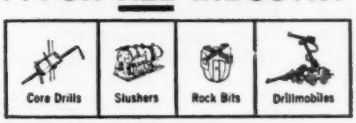


EQUIPMENT FOR MINING . . . FOR ALL INDUSTRY



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In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

MECHANICAL COAL MINING

By FRANK R. ZACHAR
Consulting Mining Engineer
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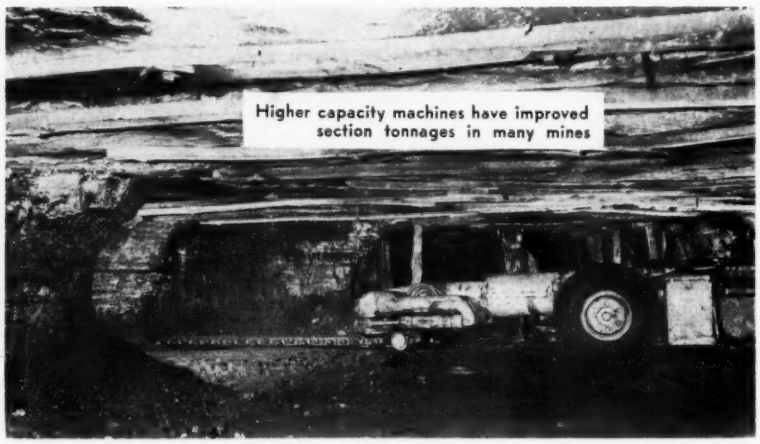


Higher capacity machines have improved section tonnages in many mines

The past year saw . . .

* Production down but efficiency up
* Higher capacity machinery covering a wider range of mining conditions
* Continuation of the trend toward a-c power
* Increased interest in industrial engineering
* Improved mining techniques and emphasis on proper equipment application

As late as April, 1958, it was predicted that a second-half upturn in general business activity would make itself felt in the bituminous coal industry, and that the year would show bituminous production equal to or only slightly less than the 490,000,000 tons mined in 1957. For various reasons this upturn did not occur, and it is only the abnormal demand occurring at year's end that will permit 1958 to show production totals above the very low year of 1954. Estimated production in 1958 is approximately 405,000,000 tons.

This decrease in production does not reflect in any way the coal industry's inability to produce, but rather the general business trend's effect upon the industry's production requirements. The consumption-export level was 490,000,000 tons in 1957, and will drop to approximately 421,000,000 tons for the calendar year 1958. Shrinkage of stockpiles and coal in transit has caused mine production to lag about 16,000,000 tons behind consumption-export totals for the year.

A decrease in U.S. consumption of metallurgical coal accounted for the largest single tonnage loss in 1958. It appears that at least 31,000,000 less tons of metallurgical coal will be consumed in 1958 than in 1957. The electric utility industry has increased its power output by several percent in 1958, but will show decreased coal consumption due to gains of hydroelectric facilities and excess fuel oil and natural gas offered at extremely low prices. Actually, electric generating plants will consume about 4,000,000 less tons in 1958 than in 1957.

The steam locomotive is almost a thing of the past, and total railroad consumption dropped from 8,000,000 tons in 1957 to 4,000,000 tons in 1958. Other industrial consumption dropped an additional 4,000,000 tons from the 105,000,000 tons consumed in 1957.

Canadian and overseas export market took 25,000,000 less tons in 1958 than in 1957. The big drop was in Western Europe where industrial activity slowed up and a mild winter required less coal for heating. European stockpiles are overflowing, and a big cut in necessary import coal is expected in 1959.

Need for Low-Cost Mining More Critical

The decrease in consumption-export requirements forced bituminous coal production cut-backs, and the downward trend established in 1957 was accentuated.

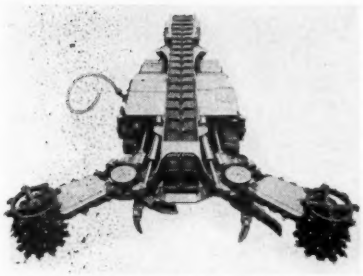
As in earlier instances, the coal industry seems to have recognized the need for increased efficiencies if costs are to be maintained and profits are to be returned on investments. Management has doubled and redoubled its effort to evolve systems and procedures that will reduce costs. The various equipment manufacturers have risen to the occasion and have devoted increased engineering time to the development of more efficient machinery for all mining conditions.

All estimates for 1959 indicate that these combined efforts are very necessary inasmuch as labor costs will increase with the terms of the recently signed wage agreement, and production forecasts tend to show only about 450,000,000 ton consumption, and export requirements. Spiralling general product and steel prices will probably cause considerable rise in mine supply costs as well. All in all, the need for low cost mining would seem to be even more pertinent during the coming year than in 1958.

Efficiency Increased 98 Percent in 20-Year Period

The bituminous coal industry has continually improved its underground productivity in terms of "tons-per-man-shift" down through the years. In 1937 the average tons-per-man-shift worked was about 4.50. Steadily increasing during the intervening years, this figure became 8.91 in 1957, an increase of about 98 percent.

This increase in productivity did



It is estimated that in 1958 the percentage of total bituminous coal production mined by continuous mining machines will exceed 20 percent

not just happen, but was the result of ever increasing efforts on the part of operating people to improve coal's competitive position—aided materially by the manufacturers' efforts to provide better and more efficient mining tools.

In 1958 it is estimated that the average productivity of the underground bituminous mines will exceed 9.35 tons per man shift. This, despite the fact that production needs were curtailed with total production dropping about 85,000,000 tons below that of the previous year. A similar situation existed in 1954, when annual production fell to a 15-year low, and total tonnage produced was 65,600,000 tons below that of the previous year, and yet underground mining increased its productivity by about 12 percent.

What Happens Within Industry During Time of Economic Stress?

It might be well to look at a general analysis of what happens within the industry during time of economic stress or recession.

Faced with the knowledge that the market is on the decline and that the immediate future holds little or no promise for a distinct upturn, the average operator first tightens up on the purse strings and his entire organization is made more aware of the necessity of economizing all down the line.

Intended purchases are scrutinized and supply inventories are checked for adequacy before orders are placed. Substitutions are considered and available materials on hand and already paid for are inventoried and put to use where possible.

Mine labor forces are reviewed, and more than usual consideration given to cutting back usage of premium rate or overtime labor. Tonnage curtailment at a mine usually begins with the loss of work time but with the mine producing normal daily tonnage. During this period the operator usually maintains the full complement of mine labor but utilizes off-days to carry out the work necessary for the upkeep of the mine and machinery that was formerly done on weekends at premium labor rates. This policy is continued until the downward production trend is recognized as an actuality rather than a temporary curtailment brought about by some short-lived condition.

When it has become apparent that sufficient work time at normal daily tonnage will not be available, the operator must then decrease daily production. It is only natural that sections working in areas where conditions or quality induce high mining costs be discontinued first. Sections operating with less efficient equipment are usually next to be discontinued. General day labor, both inside and outside, is usually cut back and less important construction projects discontinued or postponed. As a result, individual mines often show an increase in efficiency and tons-per-man shift even though total production decreases.

Through such policies the industry is forced to "do better with what they have" and usually manages to do so. While very disagreeable at the time, and the subject of untold numbers of plaintive discussions, this situation may be looked upon as a very healthy and stimulating influence. Time must be taken to consider cost control problems and all phases of the operation must be scrutinized carefully for possible revision of methods and systems to bring about mining cost reductions.

Industrial Engineering Principles More Widely Utilized

Such thinking brings about increased interest in "industrial engineering." A major aim of industrial engineering is achievement of a production system that will consistently provide the lowest cost under a given set of circumstances, and cost control through industrial engineering is based upon measuring actual costs against potential costs rather than actual costs against those of the past.

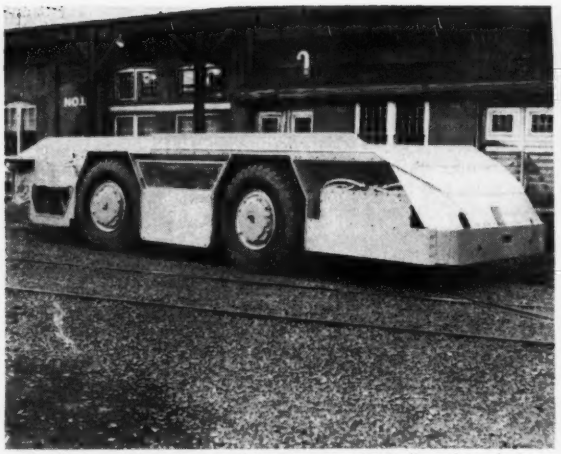
In 1958 most coal producers, realizing that necessary cost reductions could be brought about only by improved methods and systems, applied more and more industrial engineering principles to their operations. Often this may have been done without fully realizing that a form of industrial engineering was being applied. In any event the industry as a whole is more cost conscious and is compiling more and more usable comparative information regarding its operating practices than at any previous time in its history. The range of applied industrial engineering naturally varied from mine to mine, and company to company. Some firms have gone to full scale programs, including incentive programs, while others have merely given more thought and analysis to their problems, but whether at one extreme or the other, industrial engineering principles were more widely utilized on an industry-wide basis than ever before.

With over 21 years of experience in all phases of coal mining, Frank R. Zachar is able to present a keen analysis of "Mechanical Coal Mining." His background includes: mining and preparation engineer for Pittsburgh Coal Co.; mining engineer for Koppers Coal Co.; several years in operating duties at Duquesne Light Co. mines; mine superintendent at Hanna Coal Co. in Ohio, and general superintendent of Christopher Coal Co. From 1955 to 1957 he did consulting work in connection with Consolidation Coal Company's expansion program in northern West Virginia. Late in 1957 he formed his own organization and has been offering consulting services to the industry.

Developments such as the belt turn have marked advances in the design and application of conveying equipment

The results of these programs are in evidence in the fact that an increase in underground mine productivity to over 9.35 tons per man shift is expected for 1958 when all records are compiled. This increase occurred in spite of the fact that heavy production losses were incurred.

It is probably safe to say that the year saw more thought and planning devoted to continuous mining systems than in any year in the past. The days of simply purchasing continuous equipment and putting it to work by merely replacing conventional equipment seem to be gone. Today's operator has available for study a wealth of data, published in the trade journals, in the hands of engineers or equipment salesmen, and in transactions of technical societies. Projections, complete and detailed descriptions of actual systems being successfully employed, and detailed accounts of case histories are available for almost any combination of mining conditions one can imagine. These data are being used and the intelligence gained



Shuttle cars carried more than 65 percent of all coal loaded underground in 1957, and this figure is expected to increase when 1958 totals are compiled

Increased capacity of conventional loading equipment and continuous mining machines must be matched with increases in capacity of those units carrying coal away from the face

is being applied to present-day continuous mining installations.

Much more complete analyses are being made as to what operations must proceed and follow the application of the continuous mining machine and systems are evolving that are capable of producing higher shift tonnages. These analyses naturally are contributing to more intelligent purchasing of equipment and certainly are contributing to more intelligent design of both continuous mining machinery and related equipment.

This thinking has not been restricted to continuous mining alone, and conventional systems are receiving the same analyses. As a result, productivity has been increased through improved mining techniques and more proper equipment application.

Manufacturer Uses Field Research Team to Learn Mining's Problems

As stated before, and repeated for emphasis, the manufacturers of mining equipment have gone all out to aid the operator in finding ways and means to produce coal more economically and more efficiently.

Equipment manufacturers are also victims of business recessions as their customer's first action in time of economic stress is usually to stop purchasing. Available cash for high cost units is usually either lacking or held closely. This is a natural inclination and not to be unexpected.

This policy on the part of the operating portion of the coal industry certainly existed in 1958. Equipment purchases began to fall off in 1957 and the trend continued into and through 1958, and unless the unforseen occurs, 1959 will see even more selective purchasing.

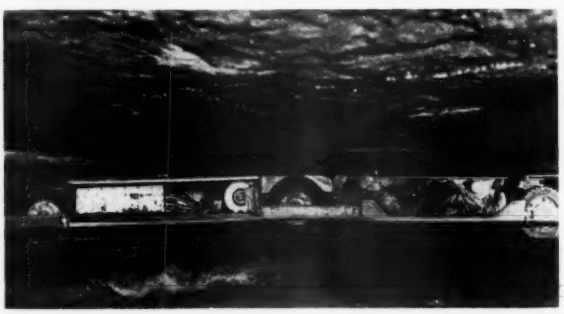
It is encouraging to note that the manufacturers are not content to make the problem of coal's recession strictly that of the operators, but, rather, are endeavoring to do more and more to aid the industry in determining what equipment needs are. One manufacturer has fielded a "research team" composed of men who design and produce that company's products. These men are going underground to talk with operators, foremen, and superintendents to learn their problems first-hand. These men have expressed the desire to listen and learn so that they can return to and carry out their jobs with a better understanding of practical problems. Other manufacturers are doing the same and increasing the efforts of their sales and service people so as to better aid the coal producer in analyzing his equipment needs.

Continuous Mining—Industry Offered Wider Selection of Equipment

The demands of the coal industry upon the manufacturers of continuous mining equipment became more exacting in 1958. More and more operators had accurate and well conceived ideas as to what the machinery they intended to purchase must do. Economic pressures plus increased knowledge of the science of continuous mining made this so. It certainly is to the equipment manufacturing industry's credit to report that they rose majestically to the occasion and, through intelligently directed hard work, were able to offer to the mining industry a much wider selection of equipment.

The year saw the introduction of continuous mining equipment designed to cover a wider range of mining conditions. With machines now available for extremely high or extremely low seams, and with machines capable of varying mining height and width as mining progresses, it is difficult to imagine a set of conditions under which at least one of the available machines will not work.

Boring machines have long been recognized as basically capable of producing at higher tons per minute while operating. However, in 1958 the gap between borer and ripper and borer and rotory-oscillating type was closed considerably. A new ripper machine, powered with 340 hp and weighing 37 tons, has a ten-ft ripper bar, can work in six ft or thicker seams, trams at 90 fpm, and has a 30-in. wide deep conveyor which moves with the head in sumping, is rated at nearly five tpm. Earlier models of similar rippers designed primarily for



The majority of thin seam production is mined with conventional equipment, and operators and manufacturers have continued to develop equipment of higher capacity

use in lower seams have had their sumping depth increased about 17 percent with consequent increase in capacity.

A manufacturer offering rotary-oscillating type miners has come up this year with two "heavy duty" machines designed for seam ranges of 42 to 102 in. and 54 to 120 in. respectively. These units have many design improvements and are rated at nearly five tpm. This same company has also developed a similar machine and is for use in seams 30 to 48 in. in thickness and rated at about three tpm. This machine can cut a face up to 16 ft in width.

Boring machine designers have gone all out to provide versatility, flexibility and capacity. Machines are available, in standard production models, for almost every conceivable combination of mining requirements. One manufacturer of multiple arm boring machines formerly restricted to mining widths of under 10 ft 0 in. now offers a medium-low machine capable of mining 15 ft 3 in. wide.

Through excellent engineering application, the coal operator now can select from an increased number of machines, each a standard unit, but each having some particular adaptation to meet particular requirements. A complete discussion of these units is not feasible herein, but it is certainly appropriate to state that an operator who has studied his requirements can certainly find, on today's market, a machine that will meet his specifications.

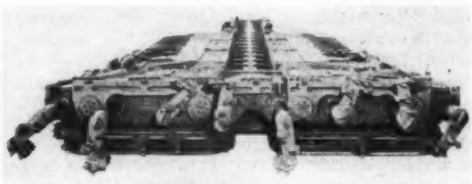
For Sulphur Ball Areas— A Continuous Conventional System

While bits and cutting arrangements have been materially improved, the old nemesis of "sulphur balls" and other pyritic inclusions in the seam still poses a problem. Operators, in general, have learned the hard way that to mine these areas with continuous mining is more often than not an uneconomical operation. In addition to excessive bit costs and undue wear and tear on the machines, shift tonnage is generally greatly reduced. It, more often than not, makes more sense to move the continuous mining machine to a suitable area where its capacity for high production and low cost mining can be taken advantage of. However, an industry sponsored agency is currently carrying out experimental work on a "continuous conventional" system employing cutting, drilling and blasting in what appears to be a well aimed effort to make at least one form of continuous mining available for these sulphur ball areas. Considerable hope is held for this system's successful application.

Production mined by continuous mining machines increased 35 percent in 1957 over production in 1956, and in these years the percentage of total bituminous production produced by continuous mining machines was about 15 and 11 percent respectively. It is estimated that in 1958 the percentage of total bituminous production mined by continuous mining machines will exceed 20 percent. The reasons for this increase are evident when is is considered that continuous mining generally offers higher shift tonnages, lower production costs, better concentration, ability to economically mine under bad roof, and ability to increase percentage of recovery. All of these advantages are those to be exploited in times of limited business activity.

Use of Remotely Controlled Machines Near

Marked advances were made in 1958 in the science of remotely controlling continuous mining machines. Recognizing that close range remote control, wherein an operator can be stationed 50 to 100 ft from the machine, can offer immediate benefits and can be developed for commercial distribution in the near future, it has been generally conceded that engineering efforts be concentrated on this type of remote control apparatus rather than on so-called long range systems. Successful short range remote control was applied to a boring type machine working in salt late in 1958 and results indicate that successful use in underground coal seams can be expected in the near future. The advantages, particularly from a personnel safety standpoint, are outstanding, and it is quite conceivable that increased over-all shift tonnage may well be expected from remotely controlled machines.



Thin-seam boring machine. The past year saw the introduction of continuous mining equipment designed to cover a wider range of mining conditions. Machines are available for extremely high or extremely low seams, and some are capable of varying mining height and width as mining progresses

Recent Developments in Conventional Mining Equipment

In recent years it has been the tendency of the industry, when discussing recent developments, to accentuate continuous mining. This is natural since this type of mining is more spectacular and tends to feed the imagination. However, of the total underground bituminous production in 1957, less than 15 percent was produced with continuous mining machines. Also, of the 1203 mines employing mechanical loading in 1957, only 33 produced all of their coal by continuous equipment. These figures have increased somewhat in 1958, but the point remains that of all coal loaded mechanically underground, about 75 percent is still loaded conventionally.

The smaller operator, lacking the capital to equip his mine with new, high capacity continuous equipment, must depend upon improved techniques of using what he has or purchasing lower cost conventional equipment better suited to his purpose. To this end, the manufacturers have endeavored to supply the industry with higher capacity equipment, designed to meet more varied mining conditions. With the ever increasing labor rate, the operator must provide ways and means of producing more and more tons per man shift to stay alive economically.

The majority of so-called low coal production is mined with conventional equipment and operators and manufacturers have continued to develop equipment of higher capacity for this large production segment of the industry.

Several manufacturers have introduced new low height loading machines with built-in high capacity, opening new production possibilities for thin seam operators.

Of more consequence however have been recent developments in low seam auxiliary equipment. Coal cannot be loaded in quantity if it cannot be prepared and transported away from the face.

One such unique unit is a roof bolting unit with a second motor powering a lightweight hydraulically operated hand-held face drill. This unit permits roof and face drilling to be done independently and simultaneously from the same unit and is only 25½ in. high and 37 in. wide.

Tremendous steps have been taken in the development of conveying systems for low coal. Multiple conveyors, so connected as to permit articulation, are gaining prominence. One manufacturer, specializing in low vein equipment, has perfected a three unit setup whereby it is possible to mine three or more headings from a single conveyor unit.

Mining machines of several manufacturers are now equipped with 75 or 100-hp continuous rated motors and

can use longer bars. These higher capacity machines have improved section tonnages in many mines.

A new light battery personnel car, with ranges up to 15 miles between chargings, only 26 in. high, has been developed to aid those in the thinner seams. Inspectors, engineers, supply men, mechanics, need ways and means to travel and carry their tools in these seams.

Several improvements have been made on roof bolting equipment for thin intermediate seams. As loading capacity increases, more bolts must be set per shift, and steps are being taken to insure this.

Of particular interest to the small truck mines, of which there are many, is the development of a single phase a-c self-propelled cutting machine. This unit is ruggedly built, hydraulically operated with cutting speeds of 24 in. per minute.

Wide Choice of High Capacity Haulage Units

Recognizing that increased capacity of conventional loading equipment and continuous mining machines must, if full benefits are to be realized, be matched with increases in capacity of those units carrying coal away from the face, the manufacturers have again gone all out in offering a wide choice of high capacity, transportation units.

Shuttle cars carried more than 65 percent of all coal loaded underground in 1957, and this figure is expected to increase when 1958 totals are compiled. The industry has expressed desires for the ultimate in capacity in these units, asking for faster tramming speeds, faster discharge rates, and the most rugged units possible. The manufacturers have met these demands and the operator has a very wide range of choices in selecting the car he feels best suited for his conditions. For example, a car driven through a torque converter now is furnished only 25½ in. high, 10 ft wide, and with a water level capacity of 3½ tons, with all components designed for heavier loads. Another manufacturer offers a 6-wheel car, only 27 in. high, and capable of discharging its 4½ ton load in 27 seconds for similar conditions. For high seams an operator can choose a car 57 in. high, powered with 65 hp and with a 15-ton load carrying capacity. A multitude of good cars are available for intermediate height seams.

Space does not permit full discussion of the improvements and additions to the field of conveying equipment. Advances in the design and application of this equipment have been varied and rapid. The operator certainly is in better position to select more proper and adequate conveying devices to suit his particular conditions than at any time in the history of the industry. If anything detrimental can be said of these developments, it might be that so much information and so many improved products are available that the purchaser might tend to become confused as to which item best fits his needs. Certainly, this is not an unhealthy condition, but one which, if intelligently handled, can result in the increased section productivity so badly needed.

While not applied directly to the transportation of coal, the problem of transporting men to and from the mine portal has become a very definite part of management's problem of increasing actual face work hours. Many mines find that too great a portion of the allotted work day is spent in traveling. New portals are not always economically feasible or possible and increased man-haulage efficiency is required. To this end the use of individual crew haulage units has been a welcome solution. Increased use of these units have been sound financial investments.

A-C Mining Gains Impetus

While not an innovation in 1958, a-c mining gained impetus during the year. Manufacturers welcome the change since the smaller frame size of a-c motors requires less space per horsepower.

Operators are continuing to embrace a-c mining because of the lower electrical delay times encountered and because of the reduced equipment maintenance costs. One operator, keeping very accurate records comparing an a-c continuous mining section with a similar section on d-c reports that the section maintenance supply cost was 56 percent lower on the a-c section. A like comparison was made for an a-c conventional section and its d-c counterpart, with the a-c section showing 31 percent lower maintenance supply costs.

The trend toward a-c power installations has already developed and should accelerate in the future.

Successful short-range remote control was applied to a boring-type machine working in salt late in 1958. Results indicate that successful use in underground coal seams can be expected in the near future

1958 Was a Year of Progress

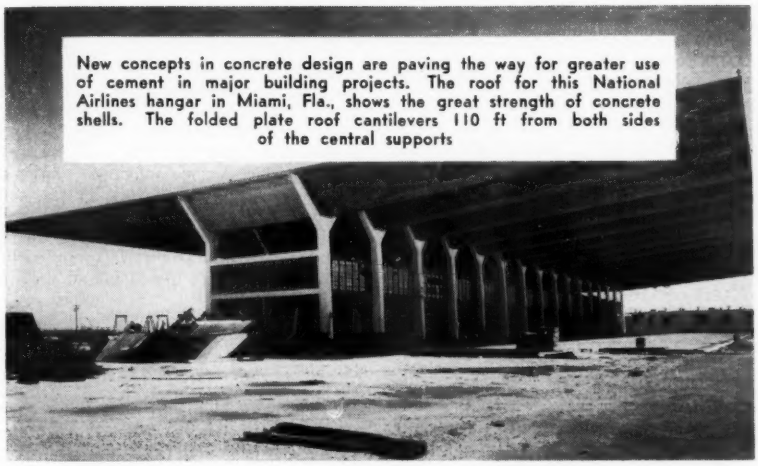
While adverse over-all business conditions, plus loss of expected export markets, caused a reduction in bituminous production, 1958 probably saw more constructive thinking applied to mechanical coal production than in many past years, and, as a result, the year will undoubtedly show the highest production per man shift in history. Since this figure is generally conceded to be the index of successful performance, it can be said that 1958 was certainly a year of progress.

The developments of improved machinery and the wider range of machinery open to selection by the operator brought about in 1958 are certainly stepping stones to increased efficiencies for the coal industry in the future. Manufacturers and coal operators are to be congratulated for the part each has played in carrying out programs so vital and beneficial to the source of this nation's major energy supply.

Cement

By CRIS DOBBINS

President
Ideal Cement Co.



New concepts in concrete design are paving the way for greater use of cement in major building projects. The roof for this National Airlines hangar in Miami, Fla., shows the great strength of concrete shells. The folded plate roof cantilevers 110 ft from both sides of the central supports

By the end of 1959 the cement industry will be able to look back on one of the most active and successful decades in its history. The 1950-59 record of shipments will total in excess of 2.7 billion bbl. With new markets and new concrete construction techniques creating an increased demand, the long range outlook is promising

DESPITE a slow start, 1958 was generally a satisfactory year. Rain, snow and cold weather blanketed practically the entire nation during most of the first three months. This unfavorable construction weather coupled with what appeared to be a mild recession, caused a poor first quarter for the cement industry. The second quarter showed little improvement; but as summer began, shipments picked up and continued at a high level through the remainder of the year.

When the final statistics are in and tabulated they will almost certainly show that shipments in the cement industry exceeded 300,000,000 bbl, and will possibly top the all time record of 303,000,000 bbl established in 1956.

Spending for new construction is expected to rise seven percent in 1959 to reach a new record of $52.3 billion, according to the annual joint forecast of the Departments of Commerce and Labor. This rise should produce a new high in physical volume, exceeding the record year of 1955 by about three percent.

This record breaking year of construction activity should reflect a record year of cement shipments also. With favorable construction weather, it is estimated that cement shipments in 1959 will increase 5 to 10 percent over 1958, or total shipments of between 320,000,000 and 335,000,000 bbl.

This optimistic forecast for cement shipments does not necessarily mean better results earnings-wise for the industry or individual companies in it. The growing threat of overexpansion and overproduction is a genuine menace in certain areas of the country. In 1958 productive capacity probably exceeded consumption by 100,000,000 bbl. More about this later; first let us look at the reasons for the increase in cement consumption.

Most of the increase forecast by the Commerce and Labor Departments is expected to come in highways and public and private residential construction, all heavy users of cement. About 1,200,000 new nonfarm dwelling units are predicted for 1959. Substantial gains are also forecast for public administrative and service buildings, schools, hospitals, sewage systems and military construction. In private construction, gains are forecast in churches, and in the stores, restaurants and garages category.

Private industrial construction is one of the few areas predicted to decline by the Government. However, a future upturn in this important area is indicated by recent surveys of business plans for capital investment. These surveys show a slight increase for 1959 in planned expenditures for new plant and equipment, the first such increase since the end of 1956. Past experience indicates that this trend is likely to gain strength as general business recovery progresses.

In addition to new construction and the general health of our economy, the increase in 1959 will be due in large measure to new uses and wider acceptance of concrete, and continuously improving construction techniques.

Let us consider some specific areas which, we hope, will be major factors in making 1959 a record year for the use of concrete:

Highway Construction

During 1958, the impact of the expanded highway program made itself felt in actual shipments of cement. Although this program was initiated

Cris Dobbins was graduated from the University of Denver in 1927. His career with Ideal Cement Co. began in 1919 with part-time employment. In 1930 he was promoted to assistant sales manager of Colorado Portland Cement Co., and in 1941 advanced to the position of sales manager. Dobbins became assistant to the president of Ideal Cement in 1943, vice president and general manager in 1944, and executive vice president and general manager in 1948. He was elected to his present position of president of the company in 1952. A director and officer of many companies, and trustee of several civic organizations, Dobbins has found time to take an active part in many American Mining Congress activities. At the recent San Francisco meeting, he was elected chairman of AMC's Western Division.

by passage of the Federal-Aid Highway Act of 1956 more than two years ago, the increased funds it provided were not used on a large scale for actual construction of pavement and structures until 1958.

According to figures compiled by the Portland Cement Association, awards for concrete road and street pavement during the first 11 months of 1958 were 92,400,000 sq yd, up 34 percent from the same period in 1957. Awards for roads alone were up 50 percent. This compares with an increase in total expenditures for roadbuilding during 1958 of only eight percent. The much larger increase in concrete pavement yardage as compared with total highway expenditures indicates two things: (1) more money was going into pavement and less into preliminary engineering and right-of-way purchases; and (2) more money was being spent on Interstate and Primary routes, where concrete is the preferred pavement. This contrasts with the situation in 1957, the first full year of the highway program, when expenditures rose 12 percent with an accompanying gain of only seven percent in pavement awards.

According to the Commerce and Labor Departments' forecast spending for highways should increase by 12 percent in 1959 to a record $6 billion. Based on this, the Bureau of Public Roads figures indicate the use of approximately an additional 10,000,000 bbl of cement for road building in 1959. Cement consumption on the Federal Highway Program should continue at this high level for several years.

Awards of soil-cement pavement also showed a spectacular gain during 1958. Through December 1 they totaled more than 42,000,000 sq yd, up 70 percent from the previous year. This market for cement, although still not among the largest, has grown rapidly in recent years and has a promising future.

Airport Paving

Awards for concrete airport pavement rose 37 percent to 18,700,000 sq yd during the first 11 months of 1958. The coming of the jet age to air travel in 1959 will necessitate substantial improvement of most major civilian airfields. This will include lengthening, strengthening and widening of runways, construction of new taxiways and aprons and enlargement of terminal facilities; and concrete is universally recognized as the safest and in fact the only practical material on which jet planes can land, take-off, or park. An idea of the magnitude of the improvements needed can be gained from the fact that $150,000,000 worth of construction is planned for New York's International Airport, and $120,000,000 worth at Chicago.

Structural Uses of Concrete

The use of concrete for structures continued to gain competitive ground during 1958. Some notable structures were erected, including the 40-story Executive House in Chicago, tallest reinforced concrete building in the United States, and the Little Falls project of the Washington Aquaduct in Washington, D. C., with a record 216-ft center span of prestressed concrete. Some 250 prestressed concrete bridges went into service on the Illinois Toll Road. In its economy and speed of construction, prestressed concrete continues to be highly competitive for the many thousands of bridges required in the expanded highway program.

Ultimate Strength Design

One of the most important developments in structural engineering in recent years has been the increasing acceptance of the ultimate-strength method of designing concrete structures. This method was included in the American Concrete Institute code for the first time in 1956. The ultimate-strength method takes-more realistic account of the actual strengths of present-day concrete and reinforcing steel, and uses more precise safety factors than the present generally used method, which was developed some sixty years ago. It will allow higher buildings and longer spans, improve the competitive position of concrete for many applications, and save many millions of dollars of future construction costs without in any way impairing the safety of the structures themselves.

An excellent example of the advantages of the ultimate-strength method was given during 1958 by the Towne Park apartment development in Philadelphia, consisting of four 18-story buildings. Use of the ultimate-strength method of design saved at least $70,000 in construction costs on these buildings as compared with the older design method. In addition, it allowed the columns to be reduced one ft in width and two in. in thickness, adding 1500 sq ft of floor area to each building and making the apartments more attractive. This was achieved with no sacrifice of safety or serviceability.

Shell Structures

The attention of many American engineers was drawn to shell structures when the designer of one of the most remarkable buildings ever constructed spoke at a convention of the American Society of Civil Engineers late in 1958. The building, nearing completion in France, has by far the largest roof ever constructed—a concrete shell with the incredible clear span of 720 ft. The roof is literally large enough to enclose a major league baseball stadium without a single column to block the view.

One outstanding shell structure completed during 1958 was a hangar built for National Airlines in Miami, Fla. The "folded-plate" roof of this structure cantilevers out 110 ft from both sides of a central support.

Prestressed Concrete

The rapid growth of the prestressed concrete industry continued during 1958. One survey estimated that there were 385 prestressing plants in operation at midyear, and the 31 more were planned to be in operation by early 1959. Total sales of prestressed units were estimated at well over $200,000,000. All of this growth has occured since 1950.

Another survey indicated that production of prestressed units was about 10,000,000 sq ft of bridges and 18,000,000 sq ft of buildings during 1957. According to this survey, growth of the industry had been at the rate of 200 to 300 percent per year since the first plant was established in 1950.

Modern cement plants use automatic controls to a high degree. Pictured is the control room of Ideal Cement Company's new Houston plant

Lightweight Aggregates

The lightweight aggregates industry has been growing almost as rapidly as the prestressing industry. A recent survey forecast that production of lightweight aggregates in 1959 would be more than 11,000,000 tons, about 10 times the 1950 production. Expanded clay and shale have grown fastest. The largest markets for lightweight aggregates are still concrete masonry and basecoat plaster, but the amount of structural concrete using them is growing rapidly, and a considerable amount of research on their use in prestressed concrete is being conducted.

An outstanding application of lightweight aggregate during 1958 was the Brown Palace Hotel in Denver, Colo. Lightweight aggregate was used throughout in the basic structure of this 22-story building.

It has now been proven conclusively that lightweight aggregate can be scientifically manufactured which makes possible concrete having strengths equal to the best of the natural aggregates, but with approximately one-third less weight. In time this development should greatly broaden markets for cement.

Concrete Products

The production of ready-mixed concrete and concrete masonry apparently dipped slightly during 1957 after many years of steady growth. There are no completely reliable recent figures on these industries, but it appears that both resumed their growth in 1958. Since a large proportion of their production is consumed in homebuilding, an increase in 1958 would seem likely because of the slight increase in homebuilding.

In both industries, a growth rate somewhat higher than the over-all growth rate of construction seems likely to continue. On-site mixing of concrete for any but the largest projects has become increasingly rare—ready-mix is more convenient and uniform, and usually cheaper. Ready-mix producers are expanding into new fields daily, and are currently showing more interest in road and street paving, one of the few major concrete markets where on-the-job mixing until now has been the rule.

Producers of concrete masonry are also looking to new markets for expansion of their industry. Although block currently is used for about two-thirds of the total volume of masonry walls, it is still regarded in some sections of the country as purely utilitarian, and not suitable for applications where appearance is important, such as in the walls of houses. Block manufacturers are attacking this problem by producing a wide variety of new patterns, textures, colors and sizes. The housing market offers great potential for concrete masonry. With attractive new units, block manufacturers expect to find growing acceptance of conrete masonry for above-ground uses, matching in other areas the increasing popularity it now enjoys in the Southwest, Pacific Coast and certain other regions.

A third major concrete product, pipe, continued to enjoy steady growth. Production in 1958 was estimated at about 13,000,000 to 14,000,000 tons. Based on the Bureau of Public Roads' estimates and the Commerce and Labor Departments' forecast, an additional 385,000 tons of pipe is indicated for highways alone in 1959.

New PCA Laboratories

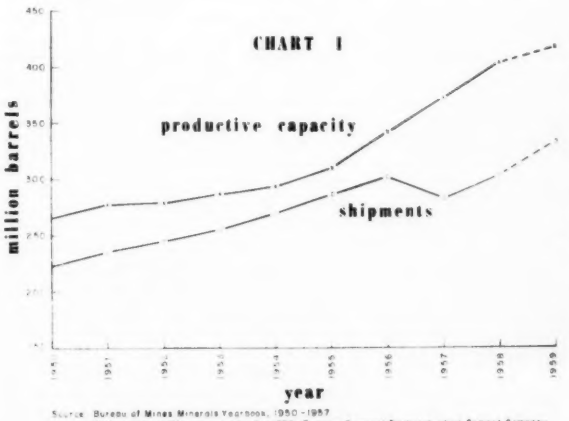
Of special importance to the future of newer uses of concrete was the completion during 1958 of two new laboratory buildings near Chicago by the Portland Cement Association. One of the buildings, a Structural Laboratory, is capable of applying test loads of up to 10,000,000 lb on full-scale structural members. This laboratory is already obtaining needed information on prestressed concrete, connections between precast units, shell structures, and other subjects of immediate importance. The second new building, a Fire Research Center, will be in full operation early in 1959. This laboratory will be the first in the United States used primarily for research in fire resistance of full-scale members rather than solely for fire rating tests.

As mentioned earlier, the problem of increasing productive capacity is becoming acute in some areas. (See Chart I.) At present there appears to be more than 100,000,000 bbl of excess productive capacity, which means there is enough, on a nationwide basis, to handle the construction industry's increasing demands for the next several years. As of the year end there exists approximately 406,000,000 bbl of capacity with apparently an additional 12,000,000 to be added in 1959. It is, of course, a well known fact that overcapacity can be a serious economic threat, but it is generally thought that the increasing usage of cement may catch up with this apparent overcapacity by 1961 or 1962 at the latest.

The importation of foreign cement continues to be a minor but disturbing factor in some areas. It is hardly likely that this can be profitable to foreign producers except as they are willing to ignore costs in order to secure dollar exchange.

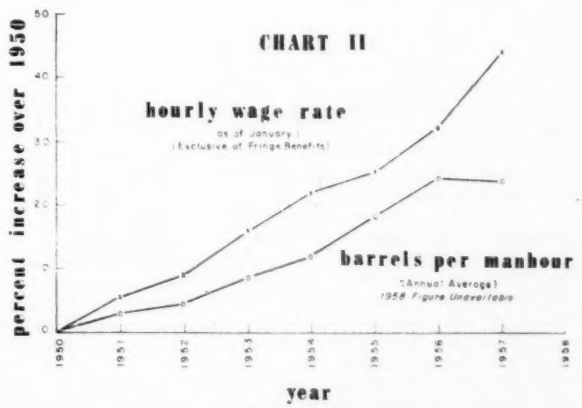
The cement industry as with practically all others is caught in the inflationary spiral cost-pricewise. Steadily rising costs and the generally in-

(Continued on page 57)



Source: Bureau of Mines Minerals Yearbook, 1950-1957
Estimate for 1958 and projection for 1959, Business Research Dept ment, Ideal Cement Company

One of the major problems facing the cement industry is that of rising productive capacity. At present there appears to be more than 100,000,000 bbl of excess capacity—enough to handle the construction industry's increasing demands for the next several years

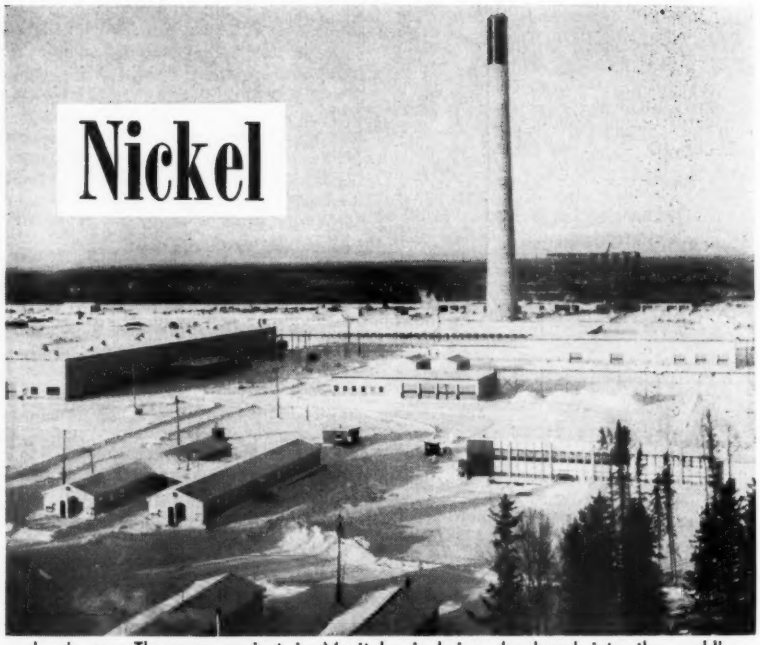


Hourly wage rates have risen at a far greater rate than hourly productivity. The only two ways of meeting this problem are higher cement prices, or increased manhour productivity. However, no price increases have been quoted for the calendar year 1959

Nickel

By HENRY S. WINGATE
President
The International Nickel Company
of Canada, Limited

The year 1958 presented the nickel industry with a great challenge—a challenge which is new and different for most free world producers. For the better part of a generation their problem has been to produce all the nickel which the market wanted. They are today challenged to make nickel so much more wanted that all the nickel which can be produced can be profitably marketed



Inco's new Thompson project in Manitoba is being developed into the world's second largest source of nickel. Annual output is scheduled at 75,000,000 lb of nickel in 1961. The completed 500-ft stack is shown with smelter construction in the background. At the left center is the shops building; in the center is the garage with the warehouse behind it, and the office building is at the right foreground. The buildings at the left foreground are temporary quarters for construction workers

AFTER years of maximum production, the industry in 1958 produced substantially below its capacity. International Nickel cut back production three times; and for a period of three months its mines were shut down by a strike. Yet Inco ended the year with unsold nickel. The United States Government-owned plant at Nicaro, Cuba, faced with accumulating supplies and reduced demand, cut its production rate well below capacity. Two relatively small producers—Nickel Rim Mines Ltd. in the Sudbury district of Ontario and Western Nickel Ltd. in British Columbia—were forced to stop production entirely.

Free world nickel consumption in 1958 is estimated to have fallen to between 325,000,000 and 335,000,000 lb from the record consumption of 415,000,000 lb established in 1957. The principal reasons for this sharp decrease were the decline in industrial production in the United States and Canada, particularly in the output of durable goods, and a further reduction in consumption of nickel for defense requirements. These conditions were accompanied by a substantial liquidation of nickel inventories held by consumers at their plants. As a result, nickel deliveries to industry were well below consumption.

In 1957, the United States Government made available to industry all of the nickel, amounting to an estimated 117,000,000 lb, originally scheduled for its stockpile intake in that year. Much of it was taken up by industry both for immediate use and for build-up of inventories. In 1958, the entire 135,000,000 lb scheduled for delivery to the United States Government stockpile was made available to industry; but, despite the three-month strike shutdown at Inco, none of these diversions, with the exception of some of the Government's Cuban production, was taken up and the great bulk remains therefore in the Government inventories. The Government has announced that in 1959 it will again be prepared to offer to industry all of the nickel which previously had been scheduled for stockpile intake during this year. It is expected that without resort to any of this nickel there will be more than ample supplies available for all purposes from private producers and that further large quantities will therefore accumulate in Government inventories.

The current dimensions of the nickel marketing problem are reflected in the industry's nickel-producing capacity at the end of 1958. While nickel consumption during the year amounted to 325,000,000 to 335,000,000 lb, the annual nickel production capacity of the free world soared to approximately 525,000,000 lb.

Canada is Principal Producer

Canada continues as by far the free world's principal source of nickel. The world's largest reserves of developed sulphide ores of nickel are in the Sudbury district of Ontario, where International Nickel operates five underground mines and an open pit, and carries on concentrating and smelting operations. Nickel is refined at the company's Port Colborne, Ontario, Canada and Clydach, Wales plants. In 1958, Inco's annual nickel production capacity rose to some 310,000,000 lb. Falconbridge Nickel Mines Ltd. also operates five underground mines in the Sudbury area, the output of its smelter being shipped to Kristiansand, Norway, for refining. The present nickel production capacity of Falconbridge exceeds 50,000,000 lb a year. The third largest Canadian producer, Sherritt Gordon Mines Ltd., operates underground mines at Lynn Lake, Manitoba, and a refinery at Fort Saskatchewan, Alberta. The capacity of its refinery has risen to 27,500,000 lb of nickel per year, including capacity for the treatment of custom concentrates.

The other principal sources of nickel are Cuba, the United States and New Caledonia. Cuban production declined in 1958 because of lower demand as well as internal disorders in that country. In August it was announced that the production rate of the United States Government-owned plant at Nicaro, Cuba, had been cut from some 50,000,000 lb a year to 35,000,000 lb. In the United States, the bulk of domestic output comes from the M. A. Hanna Company's deposit at Riddle, Ore., the capacity of which is estimated at approximately 18,000,000 lb per year.

Henry Smith Wingate attended Carleton College, Northfield, Minn., receiving his undergraduate degree in 1927, and the University of Michigan Law School, from which institution he received the degree of Juris Doctor in 1929. His active connection with International Nickel began in 1930 when he was associated with its General Counsel. In 1935, he joined International Nickel as assistant secretary. He was elected secretary in 1939, a director in 1942, vice president in 1949, president in April, 1954. He is also a member of the Executive and Advisory Committees of the company. Active in several other companies and numerous civic and professional organizations, he was honored in 1957 by being granted an honorary Doctor of Laws degree from the University of Manitoba, in Winnipeg.

Up to 2,000,000 lb per year more can be produced in the United States as a by-product in copper refining and from the National Lead Company's lead-copper-nickel-cobalt deposit at Fredericktown, Mo. The remainder of the free world's current capacity is based principally on ores coming from the island of New Caledonia.

The dimensions of the nickel industry's marketing problem, however, are greater even than the 1958 statistics indicate. The expansion programs stimulated by the free world's burgeoning defense requirements, and by government stockpiling, will not be completed until the 1960's. In 1961, the free world will have an annual nickel production capacity of the order of 650,000,000 lb, an increase of more than 100 percent in a single decade. More significant in the light of market conditions, the 1961 capacity will exceed the record nickel consumption of 1957 by over 50 percent and 1958 consumption by about 100 percent.

Manitoba Project Proceeding On Schedule

Through its new nickel mining project in Manitoba, which will become the world's second largest source of nickel, International Nickel will add 75,000,000 lb to its present annual capacity. This is more than half of the free world's increase in annual production capacity scheduled to be attained between now and 1961.

The Manitoba project is proceeding toward completion without interruption. During 1958 a force of up to 2000 men was engaged in development work at the Thompson Mine. The production shaft reached its full depth of 2100 ft in November, and stations have been established every 200 ft below the 400-ft level. The 1057-ft development shaft was completed in January 1958, followed immediately by lateral driving. Both shafts have been connected at the 1000-ft level. From the inception and to the end of 1958 capital and exploration expenditures by Inco and others incidental to the project, including the supporting power, townsite and housing facilities, have reached some $80,000,000.

Other Programs Will Increase Productive Capacity

Freeport Sulphur Co. is engaged in a project to produce 50,000,000 lb of nickel metal a year from its deposits at Moa Bay, Cuba. The ore is to be mined and concentrated in Cuba, and shipped in slurry form by tanker to a refinery being built at Port Nickel, La. Freeport has announced that all phases of the operation are proceeding on schedule, and that production is expected to begin in the summer of 1959.

Other free world producers of nickel are also engaged in expansion programs. In Canada, the annual capacities of Falconbridge and Sherritt Gordon are expected to be 55,000,000 lb and 27,500,000 lb, respectively. Annual production capacity from Cuban ores is estimated at 104,000,000 lb, with the United States Government-owned plant at Nicaro providing 54,000,000 lb, and Freeport Sulphur Co. the remainder. Capacity for production of nickel of United States origin will probably remain at about its present level of 20,000,000 lb, while published reports have indicated that if markets were available Societe le Nickel could increase its capacity to approximately 50,000,000 lb yearly from its mines in New Caledonia. In Japan, there will be some production from ores imported from New Caledonia.

The International Nickel Company of Canada, Ltd. has the same faith in the future of nickel which has guided its production, research and marketing activities over the years. Since the discovery of the Sudbury deposits 75 years ago, it has developed more and larger markets for nickel by promoting the use of this remarkably versatile metal wherever its use was technically and economically sound. Today, with even greater vigor, it is seeking further to expand existing nickel markets and to create new markets. It is in the long-term interest of all nickel producers to contribute the strength of their resources in common cause in behalf of nickel which faces intensified competition from other materials.

International Nickel's faith in nickel is demonstrated not alone by its decision to proceed with the Manitoba project. In a year in which the company's ore production at Sudbury was reduced by some 6,000,000 tons, it continued to carry forward extensive exploration programs for nickel deposits and long-range development of its Sudbury mines, long the world's largest source of nickel.

Nickel Supplies Ample For All Markets

There is no longer reason for the progress of nickel markets to be impeded by considerations of supply. The outlook for the free world's nickel industry is one of ample production resources to accommodate any foreseeable demand in the future, as well as now. With the recent improvement in economic conditions in the United States and elsewhere throughout the world, nickel demand has been rising steadily from the low levels of mid-1958. It must continue to rise, even faster, if the expanding capacities of the free world's nickel producers are to be absorbed by the market. This is the challenge to the nickel industry of the free world.

CEMENT

(Continued from page 55)

The First National Bank Building in Denver is the tallest building in the world faced with precast concrete wall panels. The panels are only two in. thick

flationary patterns of recent years continue to be a problem. Hourly wage rates particularly have risen at a far greater rate than hourly productivity. (See Chart II.) Despite this there is no prospect of lower rates for labor. There are of course only two ways of meeting this problem: (1) higher prices for the product or, (2) increased manhour productivity. In spite of these rising costs and continuing inflation, prices recently were quoted firm by many companies for the calendar year of 1959—in most cases at no increase over the price prevailing in 1958. Unless realistic prices are quoted for 1960, the cost-price squeeze could become severe.

Despite its many and complex problems the long range outlook for the industry is good if the price of the product can be increased to cover mounting costs. With all of the new markets and the new concrete construction techniques discussed in this article, plus others still in the developmental stages, the long range outlook for this basic construction material is optimistic and, in our opinion, most promising.

Metallurgists are making decided progress in the search for improved and lower-cost methods of ore treatment. One field of mineral dressing is emphasized by the author—iron ore beneficiation—where new developments carry great hope for reduced costs in the steel industry

Mineral Dressing

By LOUIS J. ERCK

Chief Metallurgist
Cleveland-Cliffs Iron Co.

IN spite of 1958 being a year of recession, planning and engineering for expansions and new facilities continued. Ordinarily a softening of the economy, such as was experienced last year, has a tendency to curtail—sometimes rather drastically—all developments that have been contemplated, and suspending or slowing down projects that are already started.

It is evident industry does not plan to sit back and wait for the recession to run its course before making plans to supplement existing facilities or to construct new plants to meet the requirements of the future. Furthermore, the planning is not concentrated upon any one mineral commodity. The diversity of interest includes titanium, gold, cement, borax, uranium, coal, beryllium, aluminum and iron ore, to name a few.

Years like 1958 are certainly trying and difficult for the operator, because reduced production schedules must be maintained and yet costs have to be held in line. The author is inclined to believe that such years as this are truly whetting stones for the mill man. One's ingenuity and imagination have to be fully extended in order to be sure of maximum mineral recovery at the least cost.

Louis J. Erck received his formal education at University of Minnesota's School of Mines. In 1933 he started to work for the Butler Brothers at Cooley, Minn., and for 13 years he was in charge of research development and plant control work. In 1948 Erck became chief metallurgist at Cleveland-Cliffs ore test laboratory in Taconite, Minn. He is now chief metallurgist at the company's research laboratory at Ishpeming, Mich. His long experience in research and development makes him well qualified to report on the progress of mineral dressing.

International Technical Meetings Prove Valuable

The transactions of the 1957 International Mineral Dressing Congress which was held in Stockholm were published last year. It is interesting to note the number of American engineers who were invited to the International Congress for presentation of papers. We are fortunate in having these papers, with their subsequent discussions, made available through the Transactions; otherwise the contributions that come from this source would remain virtually unknown.

Technical sessions and publications of the International Mineral Dressing Congress, the American Mining Congress, and the American Institute of Mining, Metallurgical and Petroleum Engineers, offer a wealth of information by which the average mill man can keep abreast of metallurgical progress.

Research and piloting of processes have continued to play an important part in furnishing fundamental information for plant design. The value of beneficiation research has been clearly recognized, as evidenced by the number of laboratories that have been dedicated in the past several years.

In many instances, the magnitude of a project requires development of the physical aspects of the problem through piloting in order to better understand the problems that arise through continuity.

The Ceveland-Cliffs Iron Co. has just completed a new pilot plant for demonstrating continuous grinding, concentration and agglomeration. Also, International Minerals & Chemical Corp. has announced a new research laboratory at Mulberry, Fla.

Plant metallurgists have a service at their disposal, which is more or less taken for granted and probably not fully appreciated, in the form of various research laboratories that have been established by machinery manufacturers and other mill suppliers. These services range from studies of crushing characteristics of the crude ores to the final stages of the flowsheet. The greatest benefit, of course, is to those operations throughout the country that are not large enough to support complete facilities for conducting fundamental studies on ore dressing practices to promote better mineral recovery and higher quality. Thus, it is demonstrated that equipment and materials

Shown is the pan type pelletizer used in Allis-Chalmers "ACL" system. Uniform pellets are discharged onto belt which carries them to the ACL traveling grate. The proportions of the blended raw mix cannot vary anywhere in the system after they are locked in pellet form, because this prevents any segregation of the finely ground raw material

suppliers are cognizant of the necessity for augmenting their advertising and sales by a followup of adequate service to be assured that the applications continue to remain satisfactory.

This is particularly true for equipment utilized in mineral recovery, such as flotation cells, magnetic separators, heavy media separation vessels, etc. Inasmuch as constant improvements are constantly being made, no one company can afford to become complacent or self-satisfied without losing out in the overall competition.

Production Facilities Continue To Increase

In spite of the recession, plans for expansions and new facilities continued to move ahead. This certainly can be recorded as overwhelming confidence in the future of the country, and an expectation of increased demands.

The field of iron ore is rather conspicuous in this respect, with several major projects underway. Bethlehem Steel and St. Joseph Lead continued their project at Pea Ridge, Mo. This project will, upon completion, have a capacity of 2,000,000 tons of high-grade iron ore concentrates in the form of pellets. The crude ore material contains sufficient iron to be considered acceptable blast furnace feed, but it contains an excessive quantity of phosphorus in the form of apatite. The phosphorus will be liberated and removed by grinding to the point of liberation, followed by subsequent concentration on magnetic separators. This project is scheduled to start some time in 1962.

The Cartier Mining Co. of U. S. Steel Corp. in Quebec, continues prog-

ress on the planning for concentrating iron ore from this area. The iron mineral is substantially all hematite, and therefore magnetic separation cannot be employed. Present plans call for utilizing Aerofall mills for comminuting the solids to approximately 20 mesh, which is sufficient to liberate the mineral. Because of the relatively coarse grind, it will be possible to use Humphrey spiral concentrators for recovery of the hematite. The coarse liberation in this instance is a decided advantage because a relatively simple flowsheet can be used for the overall ore dressing problem. Primary crushing need only be carried on to a point suitable for introducing the crude into the Aerofall mills. Since these mills are large in diameter, the trunion openings will be large enough to accept 24-in. ore chunks. The mills will thus be able to produce the desired size, somewhere around 10 mesh, in one stage. This eliminates at least three stages of crushing and two stages of grinding. Another advantage is that the reduction can be accomplished without water which, in this area of Canada, could prove to be of substantial benefit, considering the long winter periods. Because it is difficult to classify to this coarse size by air, the ultimate size classification is accomplished by closing the circuit with a screen. The screen undersize is then pulped to suitable solids and fed to two stages of Humphrey spirals for the ultimate concentration.

The resultant product will be high grade—about 64 percent iron—and will be too coarse for pelletizing. Therefore it will have to be utilized as a sinter feed unless technological developments, some of which are being worked on at the present time, permit compaction of this product and suitable binder resulting into an extrusion or briquette.

Bethlehem Steel is continuing with its Grace mine project at Morgantown, Pa. This project is also underground like the Pea Ridge, Mo., project and will require a conventional flowsheet for upgrading the magnetite ore. In this case, the grind will be regulated to produce material suitable for pelletizing. This type of flowsheet has become somewhat standardized wherever magnetite is being concentrated. Similarities are noted in comparing the flowsheets for such plants as those of the Erie Mining Co., Reserve Mining Co. and Oliver Mining Co., all of which are located in the Lake Superior District of Minnesota.

Shaft furnaces will be used for pelletizing the fine concentrate, and the resultant product will be used in Bethlehem Steel operations in this area.

Initial production of aluminum in the new plant of the Ormet Corp. was started during the year. It is anticipated that full scale production will be achieved during the year. This plant is located at Burnside, La. Ormet also has a $110,000,000 aluminum reduction plant near Clanniston, Ohio, in production.

Cement making facilities are likewise being increased throughout the country. There are two plants for the production of cement that are particularly worthy of noting, because they have departed somewhat from convention in adapting the Allis-Chalmers' process known as "ACL" or Allis-Chalmers-Lellop. In this process the raw materials to be calcined, after having been suitably ground to proper finess, are balled in a disc and placed upon a traveling grate. The first section of the grate is used for drying the green ball at a controlled temperature, so as to minimize the thermal shock. The second section of the grate is then used for preheating the dried ball at a higher temperature. The temperature in this section, however, is not high enough to cause any damage upon the grate itself, such as is experienced in other pyrometallurgical processing. At this point the grate product, still preheated and in the form of spheres, is introduced into a rotary kiln where the material is calcined to the desired specifications. The kiln product is then discharged onto a cooling device and subsequently stored preparatory to final grinding. The outstanding advantage of this process is that it is more or less a self-recuperating system, resulting in high thermal efficiencies. Two plants in the United States are now utilizing this system for the production of cement; Marquette Cement Co. located at Milwaukee, Wis., and Diamond Portland Cement Co. at Middlebranch, Ohio.

The Cleveland-Cliffs Iron Co. recently announced expansion of their facilities at Humboldt, Mich., for concentration of specular hematite by flotation. Up to now the concentrates produced from this operation have been sintered by the Ford Motor Co. at the Rouge plant in Michigan. The new plans call for pelletizing the concentrates by the Allis-Chalmers-Lellop process after suitable regrind. Pilot plant studies have shown a pellet having excellent physical properties can be produced from hematite by this system. Operations of the expanded facilities will be started in June 1960.

Hanna is moving ahead with plans for starting the concentrating plant at Groveland, Mich., possibly some time during 1959. The plant will utilize a duplex flowsheet for concentrating specular hematite. Conventional crushing will be used to produce a suitable rod mill feed size. The rod mill will operate in closed circuit with the screen, producing a screened undersize of about 35 mesh; and the screen undersize will be fed to two stages of spiral concentrators for the production of coarse concentrate. The tailings from the spiral will be further ground in a ball mill in closed circuit with cyclones to about 65 mesh. This product will then be further concentrated by froth flotation.

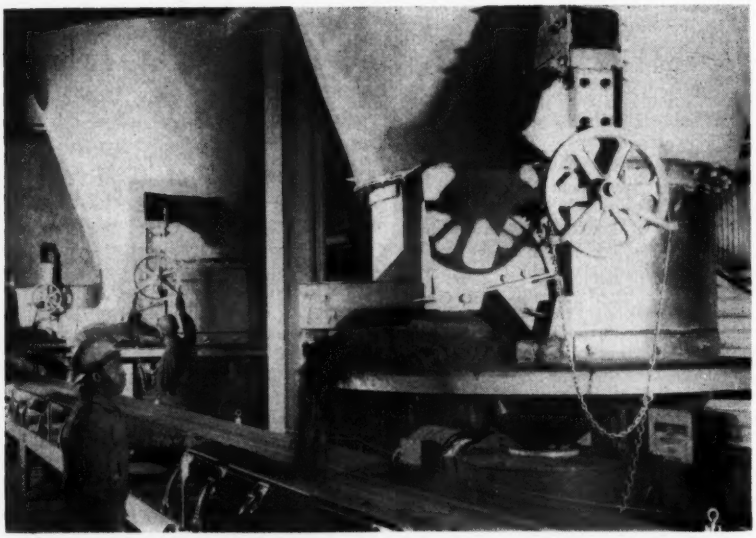
Crushing and Grinding Still Present Tough Problems

The age old problem of where to stop crushing and where to stop grinding is recognized in the taconite plants of the Lake Superior District. These plants are employing two stages of grinding, and consequently, the ratio of reduction in size during each step of processing—from primary crusher to classifier overflow—has to be essentially controlled in order to obtain a balanced control. Three stages of crushing, usually in open circuit, are used for preparing the feed to the rod mill. Unless closely watched, the proportion of oversize in the fine ore feed to the rod mill can reduce capacity. Likewise undue amounts of oversize can cause pencilling of the rods and also cause undue swelling of the rod charge. This can be corrected by either expanding the crushing facilities to four stages, which takes additional capital; or placing existing crushing circuits in closed circuit, which can have a pronounced effect on steel wear as well as the crushing capacity, or both. In an attempt to keep grinding facilities at their maximum, concessions have to be made as to the final size of crushing. A constant watch has to be kept on the settings of the third or fourth stage crusher in order to be assured of the finest product possible, taking all other factors into consideration.

As stated before, consideration can be given to expanding the crushing facilities, provided the additional capital expenditure can be warranted. Various forms of crushers, other than the cone type, have been closely scrutinized for a possible substitute which would adequately do the job with less steel wear and for less capital expenditure. Maintenance is also a controlling factor, and therefore a controlled maintenance program is needed to assure minimum downtime in changing manganese in the crusher.

Recently, attention has been directed towards a crusher which may have some application to this problem. This crusher employs the impact principle, somewhat similar to the hammer mill, and is designed to minimize steel wear. Wear parts can be easily replaced with a minimum of effort.

Two crushers somewhat similar in design and having virtually the same principle of operation are being investigated. The investigations will determine whether or not continuous testing in the plant is worthwhile in order to define maintenance costs and benefits that might be derived by reduction of the ultimate size to the rod mill.



Ore fines and other materials start toward the sintering machine in the Cleveland Works of Jones & Laughlin Steel Corp. Proportions of materials in the mixture to be sintered are automatically controlled by electric belt scales which regulate the rotational speed of the feeder disc under the hopper

These crushers are known as Tornado crusher and the D'Centegrator. They are somewhat similar in design and operation. Feed enters the machine and goes onto a rotating impeller disc. The impeller disc has four or more impeller shoes that throw the material onto a series of breaker plates. In other words, this machine acts something like a pump. The force with which the pieces are thrown onto the breaker plates is dependent upon the speed of the impeller disc. In the initial stages it was noted that there was an undue amount of wear on the impeller shoes. In order to overcome this, the impeller shoe was designed to incorporate a box effect whereby the finer material could build up, and in this manner, ore would be wearing upon ore. With this change the wear is concentrated on the tips of the impellers and the breaker plates. Both of these parts are readily replaceable without the use of bolts. Initial testing shows a decided benefit can be gained in the reduction of rod mill feed size, providing that wear and horsepower do not prove to be out of line.

This type of machine has already been introduced to the limestone and aggregate industries. One of these crushers has been installed at the White Pine Copper operation in Ontonogan, Mich., for further reduction of rod mill feed.

Only time can tell whether or not this development is going to prove to be an acceptable and competitive method for crushing.

Advances Made in Screening Techniques

Screening of ore is becoming more important. In last year's review, Norman Weiss called the readers' attention to the DSM sieve bend screen's application to the cyclone heavy media process.

This screen was used very successfully last year on the Mesabi at the Holman mine cyclone installation. Probably the screen's biggest advantage is that it has no moving parts. The contour of the screen itself is sufficient to keep the pulp flowing and still permit satisfactory screening efficiency.

Techniques for reversing the screen to equalize the wear are being studied. So far, wear has not proven to be excessive, and further development of the contour of the screen and methods for reversing will minimize replacement.

It is worth noting that the sieve bend has been so effective in removing tramp oversize that it has been possible to reduce the number of magnetic separators normally used for recovering magnetite media.

This indeed has been a very unique adaptation of screening, but is only one of the several that have been devised to fulfill the new requirements in the beneficiation of crude ore and raw materials.

Another unique screening development is in the pelletizing field. In some cases, trommels are used on the end of the balling drum for size classification of the green ball preparatory to agglomerating. In other instances, screens are used at the end of the balling drum to permit the proper size classification of the resultant green ball. Although there is a size separation, this operation cannot normally be recognized as a true screening operation. The green ball before firing must not be destroyed or marred, but must be retained in a spherical shape and delivered to the agglomerating step in as perfect condition as possible. This has been found necessary in establishing good bed porosity for equal distribution of the hot gases used for firing the green ball. To be sure the green ball is not destroyed or cracked, the screen is designed with a contour, and activated with an amplitude of motion and speed, which rolls the green ball rather than bouncing it. Rather than using screen cloths of a square mesh, rods are used for the full length of the screen which permits a sort of "toboggan slide" effect. In this way, the undersized ball is permitted to drop through, and the oversize green ball is rolled down the contour of the screen and delivered to a conveyor belt for transportation to the agglomerating device.

Traveling grates have proven successful in pelletizing fine iron ore concentrates, as demonstrated in the Reserve plant. The new Allis-Chalmers-Lellop process for pelletizing likewise uses a grate in the first step of the process. To get more capacity in one section of pelletizing, the grates are becoming wider; and this poses a problem as to how these grates should be fed. Here again, an adaptation of screening is being used not only for taking out the last traces of fines and broken green balls, but also for distribution of the load to the grate. It is rather essential to control the contour of the bed on the grate, so as to permit even heating and firing of the pellets. Grates can be anywhere from 8 to 10 feet wide, and therefore the feeder screen must be approximately the same dimension.

The blast furnace operators are rapidly moving into a program which would require agglomeration of substantially all blast furnace feed. This not only includes pelletizing of fine iron ore concentrates, but also sintering of the fines from underground direct shipping ores. These ores are very difficult to screen at the natural moistures, usually in the range from nine to 12 percent, particularly at those sizes compatible with good sintering. Usually minus ½-in. is considered a suitable sinter feed; however, there are sinter operators who would like to see the sinter feed at minus ¼-in. Because water cannot be used for making the separation on the screen, the stickiness of the ore does not permit acceptable screening efficiency. Heated screens have been used for this type of screening—in some cases with a high degree of effectiveness. Sometimes, however, the heated screen does not permit producing a clean screen oversize.

The author believes that 1959 will see the announcement of a new concept of screening which will permit separation down to ¼-in. at relatively high tonnages per square foot of screen area. This type of screening is now being examined at several locations, and if the results are as successful as those of the original appli-

cation where this screen was developed, screening will certainly have a new look.

Higher Horsepower Used in Flotation

Flotation of iron ore continues to be a subject of great interest, particularly for the Lake Superior District, for those materials that cannot be separated by magnetic means. The specular hematite formations in Michigan are readily floated by either the fatty acids or by the American Cyanamid 800 series reagents. Now that there are two plants in operation, and a third soon to be started, plant control for optimum metallurgy is being closely scrutinized. One of the more interesting facets that appears to be of hopeful magnitude is that of high intensity conditioning. To date conditioning has been effected by the conventional type conditioner impeller which uses up to 20 horsepower. In order to create the power input and the conditioning time necessary, a series conditioning has been used. A change of conditioner impeller design, along with suitable baffling, has made it possible to create higher horsepower input into a single conditioner cell. Laboratory studies so far show that by increasing the intensity, the iron unit recovery as well as the selectivity is greatly enhanced. Further work is being continued along these lines and there may be something to report on this before the end of the year.

What's New in Gravity Separators?

During the 1958 season, tests were run in several plants on the Mesabi Range using the spherical ferro-silicon developed by Dr. Rodis of Knapsack, Germany. However, the curtailed season for iron ore producers of the Mesabi Range, together with the expense of importing the spheroid media from Germany, did not permit establishment of conclusive results. The apparent benefits of spheroid media, nevertheless, are sufficiently interesting to warrant continuation of the work. Since this type of media is not made in America for heavy media separation, the product will have to be imported until the advantages are proven and it attracts the interest of ferro-silicon producers.

There is one small manganese operation which uses spheroid media. This type of media must be used at this operation to provide the high specific gravity required for separation. In this case, the media's viscosity is affected by ore slimes, so that the conventional media reaches a point of viscosity where separations are no longer possible. Spheroid media, on the other hand, permits enough fluidity at the separating gravity so as to obtain the necessary separation.

As the years go by, the ores on the Mesabi Range become more and more difficult to separate by the heavy media process. The latest development has shown that scrubbing improves the physical character of the crude material, thus permitting a sharper separation. There are several reasons for this phenomenon. First, the power input of the scrubber removes the silica coating or some of the silica scabs from the iron ore particles, thereby increasing the apparent specific gravity of the particle. Secondly, the softer middling particles in the ore are partially or totally disintegrated and release additional mineral values that would ordinarily be lost as a float product. Scrubbing also removes all loosely adhering particles and therefore permits a cleaner media, which in turn means better and more effective separations. Several of these installations are now going in at several of the plants on the Mesabi Range. Last season the scrubber installed at the Canisteo plant of Cleveland-Cliffs proved to be very successful. A similar installation is now being installed at the Holman plant of the same company. Scrubbers are being installed at the Mesabi Chief plant of the M. A. Hanna Co. William VanSlyke and R. C. Ferguson have prepared a paper on application of the scrubber to Mesabi Range practice that will be presented at the AIME's annual meeting.

Agglomeration and Compaction Offer Advantages to Steel Industry

Pelletizing fine ore concentrates produced from lean ore horizons continues to be the favored method of preparing blast furnace feed. These concentrates are so fine that they cannot be utilized as a blast furnace feed without being converted to some suitable form. At the last count there were seven pelletizing operations on the North American continent, three in Canada and four in the United States. There are several more that are earmarked to be under operation within the next few years. The blast furnace operator well understands the benefits to be derived from this form of iron ore material, not only from the physical properties but also from the chemical properties as well. For the most part, the pellets being produced are substantially in excess of 60 percent iron, which is a vast improvement, as far as iron content is concerned, over the standard ores being used as blast furnace feeds. Likewise the pellet in its best form contains a minimum amount of fines and therefore reduces the amount of dust that is blown out of the top of the blast furnace.

Erie Mining Co. and Reserve Mining Co. have plants capable of producing 7,500,000 and 5,000,000 tons of iron ore pellets, respectively. As in every new process, there are still problems; but solutions are being found which will result in more effective and efficient operations. By and large, however, pelletizing has found its place as a means of beneficiating fine concentrates, thereby producing a most suitable agglomerate for use in the blast furnace.

The field of compaction is one that is still being studied. To date compaction has not proven to be competitive with pelletizing, because no binder has been uncovered to date that will produce a compact, either in the form of an extrusion or briquette, that has physical properties equally desirable to those of a pellet. This does not say, however, that the men working in this field are discouraged, for there have been several leads uncovered which could well prove to be successful in compacting fine concentrates at a cost cheaper than that of pelletizing. This, of course, is the hope and prayer of those involved in the field of concentrating lean horizons of iron ore, and probably falls into the general category of "hope springs eternal."

Aside from this, and falling into the same vein although somewhat divorced from the field of mineral dressing, are the advances that are being made in sintering the fine ore fractions from underground direct shipping ores, and the finer fractions from beneficiated open pit ores. The blast furnace people have realized that positive control of an ore's physical properties permits higher yields and substantially reduces coke requirements. These gains have become of such magnitude that serious consideration has to be given to the idea of eliminating all fine materials that heretofore have been used as blast furnace feed.

Where Do We Go From Here?

Just as the mills of the gods grind slow, so at times does progress seem to move. Competition, on the other hand, is becoming extremely keen from foreign sources and we are moving into the lower grade horizons of ore materials. These trends are accelerating ingenuity to promote techniques of greater efficiency.

These endeavors are moving in all directions and emanating from many sources. We therefore have to be ever mindful of the full value of humbleness, and not permit ourselves to become complacent in assuming that all problems can be solved in our own backyard. We have certainly created a world-wide cooperative atmosphere, and we should study all technological information for application to our own immediate problems. These remarks also apply to the opportunity of shaking hands with our Russian associates in the field of engineering. The exchange of visits between American and Russian engineers in the field of mining and steel making could well mean a closer association for exchange of ideas, with the Iron Curtain no longer being a barrier.

An exchange of ideas has also been enhanced by the opportunity of receiving translations of the Russian abstracts on virtually any subject.

All of the mining industry is faced with increasing labor and supply costs, but strip mines must also meet the ever-increasing costs of surface acquisition

STRIP MINING of COAL

New techniques and improved equipment boosted efficiency

By EDWIN R. PHELPS

Vice President
Pittsburg & Midway Coal Mining Co.

APPROXIMATELY one-fourth of the Nation's annual coal production is now being produced by strip mining. This segment of the coal mining business is made up of a multitude of operations with a tremendous variance in size. The average strip mine operation produces approximately 75,000 tons annually and, at the same time, there are several strip mining operations that will produce this same tonnage in less than ten days' operation. This extreme variance in size naturally requires a like variance in equipment. Productivity is, of course, much higher than in the underground mines. However, the strip miners point proudly to continual increases in tons per man day. The year 1958 was no exception, and many new concepts were introduced or definitely proven throughout the year.

Drilling and Blasting Improvements

Possibly the most important advancement in strip mining techniques in the last several years has been the use of commercial grade ammonium nitrate as an explosive. Although credit for this advancement should go to Bob Akre of Maumee Collieries, since his initial introduction many of the mines and powder companies have done a tremendous amount of experimental and testing work. Results of this work include various additives—including coal dust and fuel oil—numerous mixing techniques, various hole loading techniques and many detonating methods, including the use of high grain detonating cords.

One process of particular interest is the use of untreated nitrate which has increased its speed, and pressure packing of the nitrate which has increased its density. In both horizontal and vertical holes, use is now being made of a new technique of mechanically loading the hole. This system, called blow charging, consists of a high pressure blower which is equipped with a hopper and a long hose. Both the nitrate explosive and the tamping material are handled by this machine. Blowing the nitrate into the hole removes the necessity of packaging; it also results in complete filling of the drill hole and, along with better compaction, results in more volume of powder per hole. If the drill holes are wet, a long polyethylene tube is pushed into the hole, then the nitrate is blown into the tube. Also for horizontal holes mechanical tamping machines are now being used, some employing the use of aluminum rods and others using a relatively stiff plastic rod which is fed back and forth by a machine installed on a crawler-mounted or rubber-tired tractor. Both of the above innovations, reduce to one or two men, the relatively large crew of men required to manually load and tamp holes.

Considerable improvements have been completed on the horizontal rotary-type air drill rigs which are much more efficient than an auger and will drill harder material at a faster rate. Their use makes possible the drilling of larger diameter holes which, in turn, gives the added advantage of heavier loading of explosive. Many areas are unsatisfactory for vertical drilling due to unconsolidated top material, irregular surface or heavily wooded areas which make the use of vertical drills extremely difficult. The horizontal drill holes, drilled entirely in the material to be blasted, prevents unnecessary drilling through material that can be dug without blasting. Several of these machines have been improved throughout the year, and plans are in the engineering stages for a production drill of this type.

Horizontal auger drills have been used for many years as a drill tool and have been mounted on tractors, trucks and every other conceivable type of conveyance. During the past year one mine mounted a horizontal rig on the boom of a loading shovel. This not only makes the drill extremely portable, but also permits

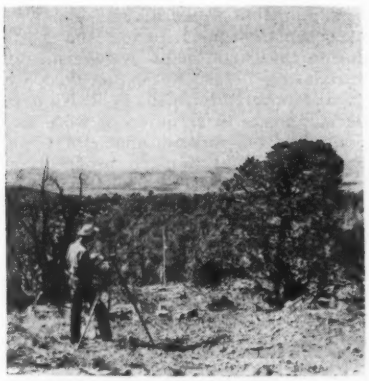
(Continued on page 66)

Edwin R. Phelps is particularly well fitted to present a review of the strip mining industry. A director and vice president of Pittsburg & Midway Coal Mining Co., he is also chairman of the American Mining Congress Committee on Strip Mining. In addition to his other industry activities, he was a member of the team of American coal experts that visited Poland in the summer of 1957.

Mining Geology

An increase in exploration abroad illustrates the growing trend toward foreign investments by American mining interests. Favorable tax concessions, higher grade ores and lower labor costs are the major factors responsible for this trend

By C. F. PARK, JR.
Dean, School of Mineral Sciences
Stanford University



Although domestic exploration was curtailed somewhat during 1958, the decrease in activity was spotty. Larger mining companies did not lay off many geologists or exploration engineers during the year, but in general hiring was stopped and exploration work was consolidated and slowed

THE depressed condition of the mining industry, so evident during late 1957, continued into early 1958. Heartening signs of strengthening and general upturn were noticed during late spring and early summer, and work was stepped up to full scale in several branches of the industry during the autumn. As a result of the limited demands for metals during the early part of the year, exploration, research, and development were curtailed. Completion of the Government stockpiling program in all major fields likewise contributed to the slackening of demands. Parts of the industry were virtually at a standstill, for example tungsten mining, where but one mine remained in production in the entire United States.

Secretary Seaton, of the Department of Interior, announced on September 22, at the American Mining Congress meeting in San Francisco, that quotas would be placed on imports of lead and zinc. These quotas were set at 80 percent of the 1953-1957 average, and were designed to cut imports about 33 percent below their present levels. They will allow imports of 354,720 short tons of lead versus a five year average of 481,638 tons, and 520,960 short tons of zinc versus a five year average of 651,638 tons. Although the quotas established are short of the tariff protection demanded by a large segment of the domestic industry, they are flexible in enforcement. Improved prices combined with generally better economic conditions seem to be restoring confidence.

Foreign Exploration Increased

Although exploration was curtailed in 1958 as a result of the lessened demand for metals, the decrease in activities was spotty. The larger mining companies did not lay off many geologists or exploration engineers during the year, but generally speaking hiring was stopped and exploration activities were consolidated and slowed. In many places abroad exploration activities were continued unchanged or were even expanded. This increase in exploration abroad serves to emphasize the fact that more and more mining companies are turning to foreign deposits. This is done for a variety of reasons, among which are favorable tax concessions, higher grade ores, and lower labor costs. It boils down to the fact that foreign ores can be mined, beneficiated, and marketed more profitably than those at home. The trend toward foreign investments by American mining interests has been growing and is expected to grow even more rapidly in the future. The lack of unanimity of opinion concerning the proposed tariff protection for lead and zinc is a good expression of the division of interest between domestic and foreign operations. Agitation for protective legislation has had a deep influence on the foreign policies of this country during the past year. Peru, Chile, Bolivia, Mexico, and Canada, as well as other countries that depend in large measure upon exports of mineral commodities, have worried about possible restrictions in trade. United States companies with large foreign holdings were understandably reluctant to encourage restrictive legislation, and they were also worried about retaliatory actions by affected countries.

Another trend that is becoming increasingly noticed is the entrance of foreign mining companies into competition for high grade deposits in under developed areas. The principal limitation of such companies is a lack of venture capital, part of which they are now actively seeking in the United States. This trend is expected to accelerate in the future, especially after the European Economic Union begins to function effectively. Japan has also greatly increased activities along the western coast of South America. Japanese engineers and geologists have examined many properties, especially copper mines, and several properties have been purchased and are being developed.

Change in Law Helps Prospector

On September 2 the President signed a long needed revision in the mining laws that will permit geological, geophysical, and geochemical work on unpatented mining claims to serve as the annual assessment requirement. Such exploration methods are limited to two consecutive years or a total of five years for any one claim. The Office of Minerals Exploration in the Department of Interior, has replaced DMEA. In the future, assistance to mines will be restricted to 50 percent of costs, a reduction from the former upper limit of 75 percent. The DMEA program was well received and was well and fairly conducted. It encouraged a great deal of exploration that would otherwise not have been done.

Charles F. Park, Jr., needs little introduction; he is already well known to the mineral industry. He received his undergraduate training at New Mexico School of Mines, and was awarded advanced degrees from University of Arizona and University of Minnesota. Park rose from junior geologist to geologist in charge, Section of Metalliferous Deposits, during his 1930-46 service with U. S. Geological Survey. In 1946 he became professor of geology, Stanford University, and has distinguished himself since 1950 as dean of the University's School of Mineral Sciences.

Exploration for uranium ores was exceptionally quiet during the year, due to the curtailment in government purchasing. Most work was done by producers already in the field. No new developments of significance were announced from either Canada or from South Africa. Extensive prospecting was carried on in Southern Rhodesia, but the results are not yet known. Discoveries were annouced in Switzerland and in Japan, but the size of the deposits is unknown.

In spite of the low prices of metals and the depressed condition of the mining industry generally, geological employment remained at a fairly high level, owing to sustained and increased activities abroad. The greatest area of unemployment was among college students and recent graduates —an area long neglected by much of the mining industry, and one upon which company futures depend.

The United States Geological Survey published several excellent papers during the year, among which are Professional Paper 308, *Geology and Ore Deposits of the Jerome Area, Yavapai County, Arizona,* and Professional Paper 287, *Geology and Magnetite Deposits of Dover District, Morris County, New Jersey.* A few outstanding articles appeared in the journals of the profession. One by F. G. Snyder and J. W. Odell, published in the bulletin of the Geological Society of America, calls attention to the importance of sedimentary processes in localizing ores. In southeast Missouri it was concluded that submarine slides during the accumulation of sediments, increased the permeability of the rocks so that ore-bearing fluids could enter and circulate freely through them. Several excellent articles appeared in the journal of Economic Geology. Among these may be mentioned "The Environment Control of Sedimentary Iron Minerals" by N. K. Huber; "En Echelon Folding" by J. D. Campbell, and "Geologic Characteristics of Fluorspar Deposits in the Western United States" by W. C. Peters. A paper presented by E. L. Ohle at the AIME national meeting and entitled, "Some Considerations in Determining the Origin of Ore Deposits of the Mississippi Valley Type" received much favorable comment.

Geophysical-Geochemical Methods Find Greater Use

Geophysical prospecting continues to be increasingly used, especially the airborne magnetometer and electromagnetic equipment. As in past years several mining companies have found it advantageous from a cost standpoint to pool their resources for geophysical studies of large areas. During the past year several noteworthy studies of this sort have been conducted, especially in Canada and Africa. For example, in the Tetagouche area of the Bathhurst Mining District, New Brunswick, the combined use of airborne and ground electromagnetic surveys resulted in the discovery of four sulfide bodies, at least one of which appears to be economic.

On September 2 the President signed a long needed revision in the mining laws that will permit geological, geophysical, and geochemical work on unpatented mining claims to serve as the annual assessment requirement

Helicopters are becoming widely used for exploration in difficultly accessible areas, particularly in the Arctic, where the equipment is used to carry geologists over the lower brushy slopes of the mountains, thus greatly speeding up their work. Increased use continues to be made of aerial photographs, the study of which can save considerable time in the field and frequently furnishes structural details that might otherwise be missed.

Geochemical prospecting has been speeded up by improved methods of field analyses. According to an article published in the *Canadian Mining Journal* such a speedup was encouraged by improved spectrographic methods of soil analysis. An interesting geochemical survey of a peridotite plug 7000 ft long by 1000 ft wide was undertaken by Fatima Mining Co. at the Bartlett Geikie nickel property south of Timmons, Ontario.

Development of a portable electronic devise for the detection of beryllium was announced at the Society of Economic Geology meetings in St. Louis. The equipment is bulky to transport, but could eventually revolutionize the search for beryllium.

Domestic Developments Continued at Slower Pace

Exploration in the United States continued at a considerably slower pace than that of two years ago, but a few ore bodies were nevertheless uncovered and developed. The Columbia-Geneva Steel Co. continued exploration and development at its orebody in the Atlantic City District, Wyoming. Inland Steel Co. announced encouraging results from the exploration program on property adjoining the Sherwood mine on the Menominee Range, Michigan. Union Carbide Nuclear Co. conducted extensive exploration in Nye County, Nevada. No announcement of a discovery has been made, but the company obtained control of 86 claims in the district. Continued development of good silver-copper ore at the Bristol mine, Nevada, furnished a bright spot in Nevada mining. Bear Creek Mining Co. continued exploration at East Tintic, and several published articles state that an ore body of silver-lead-zinc has been found. Exploration for cinnabar was being pushed in the Kuskokwim Basin, Alaska.

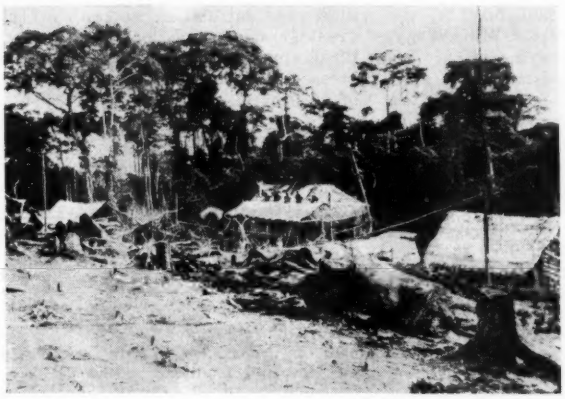
The search for rare elements slowed considerably from that of a year ago, though a small amount of interest was evident. Plans to explore and develop the thorite deposits of the Lemhi Pass area, Idaho, were announced. Rare Metals Corporation of America also engaged in a search for deposits of columbium and tantalum in the Bear Creek Valley, Valley County, Idaho.

Reynolds Metal Co. obtained control of 7300 acres in the Lake De-Smet, Wyoming, coal field as a possible power site for future aluminum reduction facilities.

Canadian Copper, Zinc and Iron Attract Interest

Exploration and development continued at a rapid pace in Canada, though somewhat reduced from the activities of a year ago. Several significant discoveries were announced. Intense activity at the Mattagami Lake area in Northwestern Quebec was sparked by the discovery in June 1957 of copper and zinc deposits by the Mattagami Syndicate. The Mattagami Lake area was virtually unexplored until this discovery was announced. Since that time, additional mineral finds have been announced by the Mattagami Syndicate, New Hosco Mines, Noranda, and by Kennco Explorations. New Hosco Mines announced that their first drill hole penetrated 77 feet of 4.01 copper, and that other excellent showings followed. Noranda is participating in exploration at Watson Lake in the Mattagami area where a major tonnage of good grade zinc ore has been indicated.

Iron ore developments continued to attract a great deal of attention. United States Steel Co., through Cartier Mining Co., continued work in the



Exploration and development have been especially active in Africa. In Gabon, French Equatorial Africa, however, very little progress was made on further study or preparation of the extensive Moamba manganese deposits. Part of the camp in this area is shown during the initial construction period

Cartier District of Quebec. In the same general region Jones and Laughlin, in partnership with Cleveland Cliffs Iron Co., leased 5640 acres in the Mount Wright area for 100 years. Both Canadian Javelin and Iron Ore Company of Canada continued active exploration and development on their properties. Special attention was given to the low grade ores suitable for concentration and pelletizing. Production and exploration of the iron ore deposits of British Columbia were greatly curtailed during the early part of the year by the enforcement of Tax Bill 87. This bill was designed to limit export of iron ore and to encourage the development of a local iron and steel industry. It essentially stopped the mining of iron ore until late in the summer when the law was declared unconstitutional by the British Columbia Supreme Court. The decision was quickly followed by renewed activity.

Johns Manville Co. announced exploration of the crocidolite deposits in the Knob Lake Region, about 680 miles north of Montreal in Labrador-Quebec. Development of the potash deposits of Saskatchewan continued about on schedule. A major exploration and development campaign was announced at Brady Lake in the Cobalt District of Ontario. In the Malartic area, Quebec, an announcement was made of the discovery of a large low-grade orebody at the Barnat mines. The discovery and partial development of magnetic anomalies near Merritt, B. C., were also announced. The ore is said to consist of chalcopyrite in magnatite.

Variety of Minerals Under Development in Latin America

Considerable development was continued on the copper deposits at El Salvador near Potrerillos, Chile, and at the Hochschild property Empresa Minera de Mantos Blancos S. A., about 45 miles northeast of Antafagasto, Chile. Progress was also reported on opening up of the deposts at Tocapala in southern Peru.

Iron ore developments continued active. Hanna Ore Co. continued an intensive exploration program on the Morro Velho property in Minas Gerais, Brazil. In Peru exploration was pushed at the Marcona mine, and the Acari property was opened by Panamerican Commodities, S. A. In Chile several small iron ore deposits were examined and developed by the Santa Fe Co.

Union Carbide continued search for manganese deposits in both British and French Guiana. In Brazil the deposit of manganese ore in the Territory of Amapa, operated by ICOMI, began full scale production.

The continued unsatisfactory tax situation in Mexico discouraged large expenditures of venture capital. The Anaconda Co. reported the discovery and development of a large tonnage of disseminated copper ore at Cananea, at depth below the Colorado pipe deposit. Continued interest and activity were manifest in Mexican flourspar, especially in the State of Guanajuato, southeast of San Luis Potosi.

Africa Scene of High Activity

Exploration and development of mining properties have been especially active in Africa, where the recent dip in metal prices apparently has been felt to a lesser degree than elsewhere. The referendum voted upon by all French Territories late in September caused several investment groups to slow down and to adopt a policy of wait and see. However, such delays were local and of short duration.

Exploration surveys continued in the Sahara desert, and in Southern Algeria discoveries of copper, lead, and zinc were announced. This exploration involved extensive aerial and ground search. In Liberia, Lamco, primarily a Swedish company, continued exploration on the iron ores of the Nimba Mountains. A major exploration program of the Tokolili iron ore deposits of Sierra Leone was nearly completed in September. This work was undertaken by the Sierra Leone Development Co. at a cost of approximately $60,000,000. In Gabon, French Equatorial Africa, very little progress was made on further exploration or development of the extensive Moamba manganese deposits. Exploration was continued by Bethlehem Steel Co. and its French Associates on the iron ore deposits of the Mekambo-Makokou area of Gabon. The Rhodesian Iron and Steel Co. announced a considerable expansion in its plant at Que Que, and is actively pushing the development of additional ore. Union Carbide Co. acquired extensive mineral rights in the Ladybrand-Clocolan district in the Eastern Free State. Ethiopia joined the growing list of countries that are endeavoring to attract foreign capital by announcing a revision of its tax laws in order to permit exemption from taxation of new mining concessions for six years. Mozambique published a new geological map, and Sierra Leone announced the completion of its aerial exploration program conducted by Canadian Aero Service, Inc.

The date of May 26, 1958, marked the attainment of a mining depth of 11,000 feet in the East Rand Proprietary Gold Mine at Boksburg near Johannesburg. This record depth was attained only after long studies of the complex mining problems, especially those dealing with rock bursts. The methods used to release rock pressures are of special interest. They involve the use of long holes and light explosive charges. Further developments at this depth will be watched with interest. The second deepest mine in the world is in the Kolar Goldfield, Mysore, India, where a depth of 10,550 feet has been attained.

Planning continued for the construction of the gigantic Jinga dam on the Congo River about 125 miles above its mouth. This dam is expected to furnish 1,500,000 kilowatts by 1965, and to have an eventual output in excess of 25,000,000 kilowatts. This very large amount of exceptionally cheap power, coupled with discoveries of what appear to be very large tonnages of good grade bauxite nearby, make the statement that "this area will become a second Ruhr", no idle boast. The main difficulty encountered to date is caused by lack of sufficient capital to push construction.

Exploration of the bauxite deposits in French Guinea was begun by an international group. Bauxite is also being sought and developed at many other places along the coast of west Africa.

More Information From Behind the Iron Curtain

The results of geological research in Russia have become better known as a result of a somewhat relaxed policy permitting visitors, and es-

pecially as a result of a report published by Dr. Pierre Lafitte, Director of the Bureau Recherches Geologique, Geophysique, et Minieres, Paris. Expenditures in Russia for geological and mineral exploration are said to be above the fantastic total of one billion pounds per year. The Ministry of Geology, engaged exclusively in geologic mapping and prospecting, has an annual budget of 300,000,000 pounds and a total staff of 200,000. The main sources of geologists are the School of Mines in Leningrad, with 5000 students; the Geological Prospect Institute in Moscow, with 1500 students, and the University of Moscow. The courses of instruction require five years. Research is mostly undertaken by institutions that are branches of the Academy of Sciences. Of the Moscow establishments, the Institute of Petrography, Mineralogy, and Geochemistry has a staff of 700, including 400 scientists. With such massive numbers of geologists in the field it would be surprising if major discoveries were not forthcoming. Probably the most noteworthy achievements are the continued extension of the diamond fields in the Jakutian area, Siberia, and the discovery of major new iron ore fields.

Russia has caused considerable unrest in the metal market by the dumping of tin, aluminum, and platinum. Dumping of tin was stopped during the latter part of the year and production returned to an uneasy but nearly normal basis. Aluminum was placed on the market at below world prices and was apparently timed at intervals calculated to cause the greatest disruption of the market. Platinum prices were greatly depressed by the selling of large amounts of the metal.

Communist China and Poland each announced the discovery of major copper deposits. In Poland a discovery in the Sierozsowice and Lublin areas is said to have uncovered a bed seven feet thick at a depth of about 2160 feet. The ore is said to average about 1.4 percent copper.

ACKNOWLEDGEMENTS

In the preparation of this review help was received from many sources. Special thanks are due to P. J. Shenon, D. M. Fraser, and to members of the Menlo Park Office of the United States Geological Survey.

STRIP MINING OF COAL *(Continued from page 62)*

its use at almost any height in the highwall.

Use of Wire Strands for Boom Supports

The year 1958 finished the first year's operation of the world's largest stripping shovel. This 70 cu yd monster, with 4400 hp of electric motors and weighing 2900 tons, is served by 7200 volts, a new high for stripping service.

Another improvement in stripping shovels during the year was the replacement of wire ropes by wire strands for boom supports. This type of cable gives longer life and, in addition, the failures commence on the outer strands which makes it possible to locate them by inspection. Standard cables usually fail from the interior, making the detection of failures difficult.

All sizes of shovels, draglines, bulldozers and scrapers are being used singularly and in tandem operations for stripping. The past year saw the addition of Alaska as one of the states and it, in turn, added a new twist to stripping. At a strip mine in Alaska, after the moss and trees have been bulldozed from the surface, huge hydraulic jets are used to sluice away the sand and gravel from the shale overlying the coal.

Highwall Method Cheaper Than Standard Underground Mining

One of the latest and most interesting methods of mining has advanced considerably during the year. The strip mining industry claims this new highwall method as an excellent auxiliary method. After an area has been mined to the maximum strippable depth, a continuous mining machine is installed and digs a series of entries at right angles to the highwall. These entries are either of 1 or 1½ cuts in width and extend back some 1000 to 1500 ft from the face. This machine, with an extensible belt following it, can produce coal at an extremely low cost providing roof conditions and draining conditions are favorable. Savings in ventilation and secondary haulage make this system much cheaper than standard underground mining, even using the same mining equipment.

Another auxiliary to the stripping industry is the use of augers. This method is not new. However, the advent of twin augers and improvements have increased the usefulness and productivity of this equipment.

In loading the coal for strip mines, considerable advancement has been made in the use of end loaders. Both rubber-tired and crawler-mounted end loaders have increased in size and flexibility to the point where they are extremely competitive with the smaller-type loading shovels. One of the biggest and most expensive problems in regard to the loading of coal has been the preparation of coal for loading. Multiple drills mounted on portable units have been used, but during the last year tractor-mounted single tooth rippers have come to the forefront. Coal seams up to six ft in thickness have been satisfactorily prepared for loading at a cost much cheaper than with the use of drills and explosives.

The use of rippers is not new. However, the pull-type was unsatisfactory because of lack of weight. The tractor mounted ripper uses the full weight of the tractor to keep the ripper in the coal at all times.

Haulage—More Payload Per Pound of Empty Weight

Coal haulage is the next step in strip mining, and the past year has seen the use of 80-ton bottom dump tractor-trailer units. The 375-hp engines with which units are now equipped will be replaced by a 425-hp engine in the near future as deliveries and installations can be made. There has been a replacement of the front axle with giant air cylinders that act as kingpins to support the front wheels, while still permitting them to be steered. The use of Manten steel and corrugated plate in the trailers make available a considerable saving in the weight of the empty trailer. This unit has a capacity equal to 2½ lb of payload per lb of empty vehicle weight. Another company has 70-ton coal trailers built completely of aluminum as another approach to this goal of more payload per lb of empty weight. With a continual improvement in torque converters and automatic transmissions, the maximum engine horsepower is kept available for the tractive power of the truck at all times. Mines that have down-hill haulage problems have found the use of hydraulic retarding equipment essential for improving safety, bettering brake life and promoting faster haulage.

The past year has also seen a considerable increase in the use of aerial photographs for mapping. Aerial surveying is not new; however, improvements make it economical to use aerial photographs for even monthly progress maps. Accurate up-to-date maps are invaluable for land evaluation, operational planning and production progress. Aerial surveying and mapping not only speeds up the map work, but is usually one-half the cost of ground surveys.

Although the tonnage for 1958 was down from previous years, much progress was made in new techniques and improvements of existing equipfaced with increasing labor and supment. All of the mining industry is ply costs; however, the strip mines must also meet the ever increasing costs of surface acquisition. To combat these increases, future years will see continuing progress in the search for lowering the cost of production.

By WOODS G. TALMAN
Assistant Vice President, Coal—Staff
United States Steel Corp.

SAFETY in MINING

Cementation of stratified roof rock . . . hydraulically-moved canopy for use with mechanical loading machines . . . experiments to minimize mountain bumps . . . yielding jacks in pillar work in lieu of cribs or clusters of timbers . . . improvement of ventilation and dust control . . . methane alarm . . . flame-resistant hydraulic fluid—these are only a few of the many subjects touched on by the author as he reviews the safety accomplishments of 1958

PRELIMINARY data for the past year indicates that the coal mining industry has made slight if any improvement in the frequency rate for both fatal and non-fatal injuries. The injury records for the metal and non-metal mining industries are not available for 1958.

Tables I, II and III show the number of fatal and non-fatal injuries that occurred in bituminous and anthracite coal mining for the years 1954 to 1957, inclusive, and for the first ten months of 1958. Tables IV and V show similar data concerning metal and non-metal mines for the years 1954 to 1957 inclusive.

Major Disasters

During the first 11 months of 1958, three major disasters occurred in the bituminous coal mines of the United States. Forty-two miners lost their lives in these catastrophes.

The first disaster occurred in West Virginia on February 12, 1958, when a fall of slate killed six men. The second major disaster occurred on October 27, 1958, when an explosion killed 22 miners. On October 28, 1958, another gas ignition resulted in the death of 14 workmen. Both explosions occurred in West Virginia.

Seventy-four miners were killed on October 23, 1958, in a mine located in Nova Scotia, Canada. It is believed that the disaster can be attributed to a mountain bump.

For use in mine rescue work, the outstanding accomplishment last year was the development of a telephone for use in conjunction with self-contained oxygen breathing apparatus. The phone enables men stationed at the fresh air base to talk with the captain of the mine rescue team at all times.

Woods G. Talman began his U. S. Steel Corp. career with Tennessee Coal & Iron Division, starting as a junior engineer in 1937. He has served as chief inspector, coal mines; assistant to the general superintendent, ore mines and quarries, and as assistant general superintendent, coal mines. In 1952 he was appointed assistant general superintendent of U. S. Steel's Gary and Lynch Districts—Coal Division, and became general superintendent two years later. Since February 1958 he has been assistant vice president, coal—staff for U. S. Steel, with offices in Pittsburgh, Pa.

Accident Prevention Measures

Falls of slate and haulage accidents continue to be the major causes of mine accidents.

Roof Control. The National Campaign for prevention of injuries from falls of roof began July 1957, and ended June 30, 1958. This campaign was probably the greatest effort ever undertaken by the coal mining industry to combat this major accident problem. A total of 1214 mines enrolled in the campaign. There were 509 less injuries charged to falls of roof at these mines during the campaign year than during the comparable base period. This represents a 38 percent reduction in the number of injuries. Using frequency rate as the basis of comparison, the reduction achieved by these same mines was 24 percent. A total of 182 mines won the "Certificate of Achievement" award. Over 3000 "Certificates of Commendation" were awarded to supervisors whose men had finished the campaign year with no chargeable injuries from falls of roof. Local unions were awarded "Certificates of Meritorious Service" at mines which received "Certificates of Achievement."

During 1958 the Bureau of Mines carried on several roof control projects. Experimental work has been in progress for some time in the cementation of stratified roof rock. Early in 1959 the Bureau will place in operation a combination rotary drill having high-pressure pumps mounted on the body of the drill. The drilling and pumping of plastics into the strata can then be done in a single on-shift operation. Another project was experimental work with a hy-

INJURY EXPERIENCE—MINES—1954-1958 INCLUSIVE

Table I. Bituminous Coal Mines

	Number of Injuries		Frequency Rates Per Million Man Hours	
	Fatal	Non-Fatal	Fatal	Non-Fatal
1954	334	14,746	0.99	43.66
1955	360	15,971	0.96	42.75
1956	392	16,486	1.02	43.00
1957	426	14,565	1.18	40.29
1958 (10 Mos.)	280		1.18	43.86

Table II. Anthracite Coal Mines

1954	62	2,972	1.23	59.18
1955	60	2,919	1.30	63.46
1956	56	3,333	1.12	66.37
1957	51	2,877	1.15	64.93
1958 (10 Mos.)	28		0.95	74.11

Table III. Total Coal Mines

1954	396	17,718	1.02	45.67
1955	420	18,890	1.00	45.02
1956	448	19,819	1.03	45.70
1957	477	17,442	1.18	42.98
1958 (10 Mos.)	308		1.16	47.19

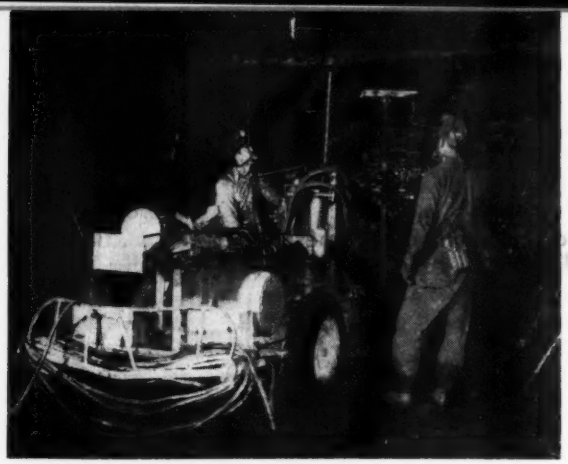
Table IV. Metal Mines

1954	86	4,994	0.66	38.27
1955	79	5,837	0.58	42.62
1956	89	5,287	0.62	36.87
1957	60	3,835	0.44	28.38
1958				

Table V. Non-Metal Mines (Except Stone Quarries)

1954	9	956	0.30	32.34
1955	19	1,156	0.61	37.18
1956	17	1,036	0.50	30.50
1957	7	950	0.21	29.04
1958				

Source of Material: U.S. Bureau of Mines



Increased mechanization of coal mines has led to a greater concentration of workers in the face areas. To combat the danger of multiple roof fall accidents, close supervision is needed to see that the mining plan is followed and roof control standards are adhered to

draulically-moved set of supports for use as a canopy with mechanical loading machines.

Some mines during 1958 used yielding jacks in pillar work in lieu of cribs or clusters of timbers. Safety advantages in using such jacks in pillar work are that the jacks start to yield at a known load, are easy to recover, and workmen can be in a safe location when the pressure is released from the jack. Workmen can detect movement of the top by watching a mark placed on the yielding part of the jack.

The increased mechanization of coal mines has increased the number of men working in groups in a small area of the mine. To combat the danger of multiple roof fall accidents requires close and efficient supervision to carry out in every detail appropriate mining plans and roof control standards.

Control of Mountain Bumps. This continues to be a major problem facing the coal mining industry. During 1958 many successful experiments were made to minimize the effects of bumps. One of the most successful methods to trigger bumps was devised by a company mining coal in southern West Virginia. An auger was used to drill a large hole into a "loaded" block of coal and gradually relieve the built-up stresses. A coal company in Utah drilled holes in stressed blocks of coal and set off a small charge of explosives to trigger bumps. Another company attempted to induce bumps by infusing "loaded" pillars with water under high pressure. To reduce the severity of mountain bumps, some operators in the Pocahontas field of southern West Virginia installed carefully laid-out mining plans which require precise execution to produce the desired results.

Ventilation and Dust Control. The increasing use of multiple fans make it mandatory to install safety protection if a fan stops. Automatic power cut-off devices and automatic or self-closing doors at the shaft bottom were installed in greater numbers during 1958.

Face ventilation where continuous mining machines are used is a major problem facing the mining industry. The Bureau of Mines, fan manufacturers and coal operators are experimenting with the use of auxiliary fans. Force or exhaust auxiliary fans, or a combination of the two, are used.

A company in the copper region is experimenting with plastic over-lay plywood for smooth lining of airways to reduce resistance.

During the past year, marked improvement in the control of dust in the face area was accomplished. Many types of water sprays, location of sprays, high pressure pumps, and wetting agents, were used on mining machines. Improvement of face ventilation also helped to reduce the amount of dust in suspension in face areas. The collection of dust through hollow drill steel when drilling holes for roof-bolts has materially reduced the amount of dust thrown into suspension during this operation. Ventilation and dust control continue to receive special attention.

During 1958 a methane alarm was tested under operating conditions. This alarm continuously samples the air at the working face and flashes red when concentrations of methane reach a pre-determined level.

A-C Power. Another step in the campaign to reduce accidents is the increasing number of mines or parts of mines using a-c equipment underground. Advantages of a-c over d-c power are increased safety from ignition and shock hazards, constant speed, and easier maintenance. Safety grounding, low ground fault currents, and fast, sensitive protective relaying with selective tripping are easily accomplished with a-c power.

The use of plastic sheathed trailing cables in 1958 has passed the experimental stage and they are being used extensively in the mining industry.

During the past year a great deal of work and experimenting was done to find a suitable flame-resistant hydraulic fluid. To date the best results have been obtained by using a water-in-oil emulsion. From Bureau of Mines tests, it would seem that the water-in-oil mixture, with 40 percent or more of water, will provide adequate fire resistance. Tests are now being carried on with 150°F temperature and 1500 psi pressure.

The use of ammonium nitrate for blasting increased extensively during the year in coal, metal and non-metal open-pit mining.

Education. During the past year, education and job training became the strongest weapons in the effort to eliminate accidents. Some companies job-trained all their employees, with emphasis on job safety analysis by the individual.

A Forward Look

The flattened curve of accident reduction in mines should be a challenge. The industry in general has gone through a major transformation in recent years, entailing a monumental task of retraining, new planning, etc., to adapt to new and complex machines.

The fact that some mines and some companies have reached new and spectacular low levels of frequency and severity contains bright promise for the future.

Without claiming any degree of omniscience it seems to the author that a number of factors are present in the best performances.

1. Recognizing that high speed mechanization and concentration in small areas require precision-type operations, plans for all face and supporting services are laid out in detail and execution rigidly controlled.

2. The human element is recognized as of paramount importance, not only through training and education, but by soliciting the viewpoint of men and direct supervisors in establishing the *safe procedures* for use and handling of machines, haulage, roof control, maintenance practices, etc.

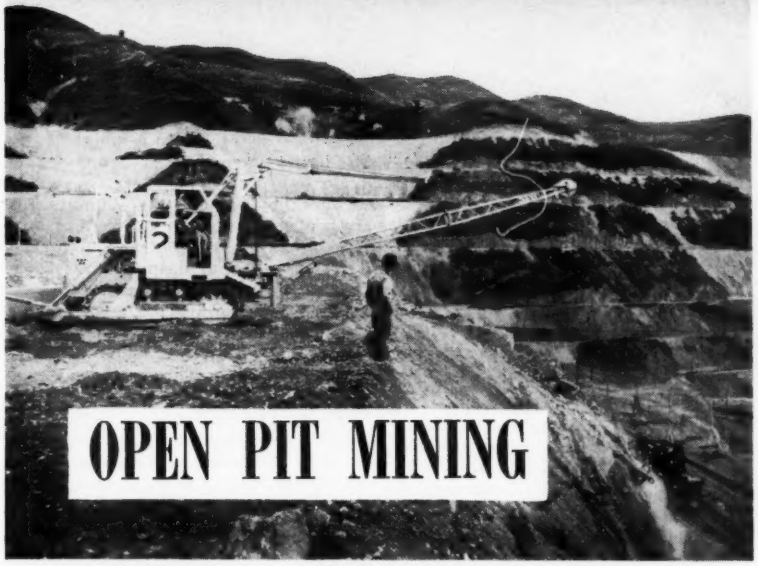
3. Full recognition is given and use made of the major agencies that are directly involved in mine safety, namely the Bureau of Mines, State Departments and the United Mine Workers' Safety Department and Committees. In making use of these associated agencies the most successful operators have recognized that management has to accept its primary responsibility, and exercise its functions sincerely, diligently and firmly.

4. Lastly, management first accepts and then inspires complete acceptance of attitudes that will not admit that accidents are inevitable, but constantly are directed to their complete elimination.

Personal Rewards

Every accident free month that passes offers rich feelings of personal fulfillment to every man at a mine, for:

GOD alone has the power to create man, whose closest approach to GODLINESS is in preserving that which HE has created.



OPEN PIT MINING

A mechanical bank trimmer is used by Kennecott Copper Corp. at Bingham Canyon. A toothed rake at the end of the cable clears hanging rocks from the bank faster and more effectively than a crew of men working by hand

By JOHN B. KNAEBEL

President and Managing Director
Anaconda Iron Ore (Ontario) Ltd.

and

H. A. MACE

Planning Engineer
The Anaconda Co.

DOMESTIC demand for the nonferrous base metals, steel and other mineral products such as cement, fertilizer, and mineral-base building materials, was slack and in some cases extremely weak with attendant low prices during the first three quarters of 1958. Some open pit mines were shut down for periods of several weeks, and others operated on curtailed schedules. Nevertheless, the pit operations suffered far less than did some of the higher-cost underground mines. As an example of the economic strength of the open pit method, the Berkeley pit at Butte operated at a substantial percentage of capacity while the bulk of the underground mines, despite their much higher ore grade, were idle until a reviving base metal market permitted resumption of operations during the last quarter.

General Activity During the Year

Strikes at some major copper producers in Africa, the U. S. and Canada, and in Chile no doubt hastened the reduction of refined metal inventories, which coupled with the lusty tempo of business in Europe contributed to the general economic recovery in the latter half of 1958—sooner than some soothsayers had predicted.

Purchase by Kennecott Copper Corp. of the mining properties of Consolidated Coppermines Corp. at White Pine, Nevada, was announced early in 1958. The well known Tripp pit was shut down in line with plans to consolidate the Veteran, Liberty and Tripp pits in the interest of orderly development and efficient overall operation.

Nchanga Consolidated Copper Mines, Ltd. brought its second Rhodesian open pit into production during the year at Chingola.

Construction of plant, transportation facilities and advance stripping of the orebody went forward apace at the Southern Peru Copper Corporation's Toquepala copper mine. Excellent costs and performance are reported in the initial stripping operations.

Efforts to reduce working capital requirements to shave operating costs, and to increase efficiency, received great emphasis and in some cases strong backing—or perhaps, more accurately, very forceful pushing—at most of the western and southwestern copper pits with resulting economies. At most of the established properties, including Bingham Canyon, Bisbee (Lavender Pit), Morenci, Ray, Ajo, Pima, Bagdad, Miami, Inspiration, Yerington, Ruth, the Butte Berkeley pit, and Cananea, operations were largely continuous; rates of output and working schedules were varied at some mines as economic conditions in the copper market dictated. There were a few interruptions caused by strikes.

One new copper pit was born in Arizona, and a famous old one was in its mortal throes: at the Duval Sulfur & Potash Company's new Esperanza pit the Isbell Construction Co. moved about 5,000,000 tons of material in preparation for early 1959 production; and at Jerome, in the famous United Verde pit, Mark Gemmill with his Big Hole Mining Co. continued to glean the higher grade streaks that remained.

Operations at the Chuquicamata pit in Chile suffered some interruption from strikes, but otherwise went forward at an excellent rate, considering conditions. During October, 1958 the mine produced 3,650,474 tons of total material in 27 working days for an average of 135,200 tpd, of which about two-thirds was ore.

Pit mining in the Michigan-Minnesota iron country, as elsewhere, was characterized by the tightening of belts and the necessity of cutting costs in the face of slack demand for ore. Most of the larger companies report no outstanding new developments or innovations in mining practice during the year. Some properties were shut down in favor of near-capacity operation of other more efficient mines; others were alternately operated near capacity for short periods and then shut down for intervals (during which maintenance was

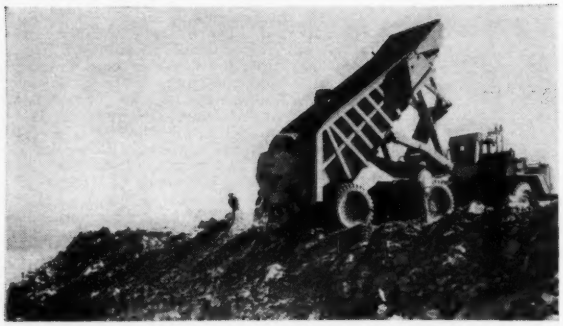
John B. Knaebel received his formal education at Cornell and Stanford Universities. After graduation from Stanford, he started his exceptionally active career as a mining engineer for the USBM in 1931. Subsequently, Knaebel held management positions with East Mindanao Mining Co., of the Philippine Islands; Amparo Mining Company of Canada, Ltd., in British Columbia, and U. S. Smelting Refining & Mining Co. In 1946 he was placed in charge of Anaconda Copper Mining Company's exploration projects in British Guiana and Brazil. Knaebel became manager, New Mexico Operations, for The Anaconda Co. in 1951, and was promoted to assistant to vice president in charge of mining operations in 1956. He became consultant to the company in 1958. The first of this year he assumed the title of president and managing director, Anaconda Iron Ore (Ontario) Ltd.

"Jack" Knaebel is this year's recipient of the William Lawrence Saunders Gold Medal for distinguished achievements in mining.

J. B. Knaebel

H. A. Mace

Howard A. Mace was graduated from Drake University in 1935. He began working for the Oliver Iron Mining Co. at Hibbing, Minn., in 1936 as an ore grader and mining engineer helper. After two years service with the U. S. Navy in the South Pacific, he returned to Oliver in 1946 as supervisor of company scramming operations and all contract stripping and mining operations. In 1950 Mace was transferred to Geneva Steel Co. as resident engineer at their Cedar City, Utah, mining operations. He left U. S. Steel in 1955 to become associated with The Anaconda Co., New Mexico Operations, as cost engineer, and was soon made planning engineer.



Kaiser Steel Corp. gets good results hauling waste at the Eagle Mountain mine in southern California with a 64-ton capacity, semi-trailer type truck which has a unique dumping action

caught up); and others went to shortened work weeks.

Steep Rock Mines in Ontario operated its Hogarth pit on a 4-day week basis most of the year, and in addition to ore mining, stripped about 1,000,000 yds in preparation for another pit. Some dredging of lake-bed silt continued. Preparations were made to deepen the pit by 50 ft, the ore below this level to be mined underground.

Unlike many of the Mesabi Range mines, Reserve Mining Co. maintained production levels, with shipments in 1958 being down only 2½ percent and mine and pellet plant production nearly equal to 1957—despite five scheduled "down" weeks compared with continuous operations the year before.

U. S. Steel's Quebec Cartier Mining Co. made good progress in construction and equipping the low-grade properties in the Mt. Wright area for production of 8,000,000 tons of high-grade concentrate per year. J&L exercised its option to take a 100-yr lease on a large iron ore project in the same region, with Cleveland Cliffs Iron Co. joining as a partner.

Two excellent papers were read during 1958 by staff members of the Marmoratan Mining Co., Ltd. (a Bethlehem subsidiary), one by Lorenson and McChesney at the Annual Meeting of the CIMM in April describing pit operations at the Marmora mine in Ontario, the other a description of blasting practice, with and without AN explosive and with combination charges, by McChesney at the National Safety Congress in Chicago in October. Both are well prepared and interesting.

The unique Hill Annex Tailings reclamation plant of J&L Steel Corp., at Calumet, Minn., is worthy of mention because of the interesting application of hydraulic dredging methods. This operation, producing 200,000 gross tons per yr of non-magnetic tailings for retreatment by flotation, began in 1957 and was well described in *Skillings Mining Review*, December 28, 1957.

A taconite reduction plant at the Groveland mine at Randville, Mich., was under construction and will be operating in 1959. The Moose Mountain mine at Milnet, Ont., was closed upon completion of its taconite-type mill and currently is idle pending market developments. Both of these are Hanna operations.

Carey Canadian Mines, Ltd. at East Broughton, Que., removed 1,250,000 yd of overburden and 300,000 tons of barren rock during the year, and went into full production of 50,000 to 60,000 tons of asbestos ore per month during September.

An excellent paper by V. I. Mann, read at the San Francisco meeting of the Mining Congress and published in the Oct. 1958 issue of MINING CONGRESS JOURNAL, described the preparations, waste disposal problems, dredging and pumping methods and other phases of bringing into production Asarco's (Lake Asbestos of Quebec, Ltd.) Black Lake mine.

Established asbestos pit operations in Quebec continued to give excellent accounts of themselves, an example being the Johnson's Co. Ltd. which operated efficiently and at low cost, despite the severe climate which requires that all equipment be winterized and suitably stored when not actively in use.

At Cassiar Asbestos Corporation's mine in British Columbia, well to the north and high above sea level (for those latitudes 6500 ft is high), operations are conducted around the clock for about three months (July-September inclusive).

The U. S. Borax and Chemical Corporation's open pit at Boron, Calif., got into full production in 1957 after nearly two years of stripping.

The Eagle-Picher Co. formally dedicated its new $2,500,000 diatomaceous earth processing plant at Lovelock, Nev., in October 1958. Earlier two mines had been stripped with large bowl-type scrapers. The ore was stockpiled as mined on the side-hill benches to insure a steady supply to the plant. From the stockpiles the material is loaded by shovels into trucks specially designed to handle this very light material (500-1000 lb per cu yd). These trucks vary from 20 to 80-yd capacity. Each mine can handle up to 250,000 yd per yr and although costs will vary with the stripping ratios, the management estimates an average mining cost of 20 cents per yd of material handled. This cost converted to a weight basis would compare well with any large-scale ore-mining cost.

At Libby, Mont., the Zonolite Co. continued to produce vermiculite at a rate of over 200 tons per man-shift (mine and shops) despite severe conditions during the winter.

Demerara Bauxite Co. operated its open pit mines at MacKenzie and Ituni, British Guiana, about as usual during the year. The trend is toward larger shovels and larger haulage units on the railroad, as well as toward wider application of automatic devices. Removal of sand overburden by hydraulicking with monitors and draglines was described in the June, 1958 issue of *Mine and Quarry Engineering*. Construction of an alumina plant on the Demerara River is in progress.

Bauxite mining in Jamaica continued to expand during 1958, with production for the year expected to double the 3,000,000 long tons mined in 1956. Much of the tonnage is loaded by long-boom draglines and hauled from the pits by bowl-type scrapers against steep grades. Long belt conveyor systems from the mining areas in the hills to shipping points on the coast are apparently working satisfactorily. Smith Bracewell wrote an interesting summary of the bauxite industry in Jamaica in *Mining Engineering*, Oct. 1958.

Uranium ore production increased at Wyoming mines as more mill capacity became available. In the Cameron area of Arizona the Mayhew Drilling Co. completed stripping 117 ft of overburden from its uranium pit; the B. B. Bonner, Jr. contracting firm of Flagstaff, Ariz., developed this 500 by 200-ft pit with dozers, rippers, tractor shovels and scrapers, removing approximately half a million tons of sedimentary overburden in the process. Established uranium pits in Colorado, Utah, Arizona, South Dakota, Washington and New Mexico, many of them small, continued to feed ore to the now rather numerous assortment of mills. Anaconda remained the largest producer in this country, operating its Bluewater plant at about 3500 tpd. Over 90 percent of this tonnage was supplied by the Jackpile open pit mine, where more than 45,000 tons of ore and waste was mined per working day. About one-sixth of the ore mined was lower grade material sent to stockpiles.

General Comments on Current Trends

Developments in equipment design continued the trend toward larger, faster and more rugged types, designed for simplified maintenance, longer life and lower operating costs. The exhibits at the September meet-

ing of the American Mining Congress in San Francisco provided an amazing display representing substantially the entire field of mechanical aids to mining. It pointed up strikingly the extent to which the heavy earth-moving field has been invaded by manufacturers whose names not so long ago were more generally linked with electric motors or aircraft engines. One infers that the Federal highway projects in prospect for the next few years furnish the primary lure in much of this development, rather than the smaller and spottier needs of the mining industry. Contractors are more willing to try out something new than are the mining companies, and rightly so in view of all the respective economic factors that affect each group.

While it is a safe generalization that the larger or faster units are economical if kept busy, nevertheless their increasing first costs tend to nullify this economy. Competition is keen and seldom is the mine operator restricted to one or two suppliers. Service remains a major and often deciding factor with operators, although habit and personal prejudice still, illogically, carries the day in some selections of shovels, trucks or drills.

Dirt moving contractors, well equipped and broadly experienced, continued to pull their weight in the industry. Examples are: the new copper pit of Duval Sulfur and Potash Co. south of Tucson where the Isbell Construction Co. was actively opening the mine; C. F. and I.'s three iron ore pits in Iron County, Utah, with Utah Construction Co. as the mining contractor; the Monsanto Chemical Co.'s and Anaconda's phosphate operations in Idaho, both of which employ the Morrison-Knudsen Co., and the Bretz quicksilver mine in Oregon, where the ore was mined by Wells Cargo, Inc. The successful contracting arrangements historical to the iron ranges continued, with some firms operating as contractors and others primarily as managers (and sometimes as selling agents as well) often with a minor proprietary interest. A number of large contractors continued their own participation in mining ventures, particularly in uranium, and in iron ore mines in South America and in some of the Western States.

Stripping Unconsolidated or Frozen Overburden

Overburden that does not require blasting is stripped in a large variety of ways, each suited to prevailing local conditions. Whether it is a "one shot" job to open a new property or a recurring operation during the life of the mine, a major consideration is the tie-up of capital in equipment that might be idle for extended periods. This consideration is emphasized by the current trend toward larger and faster stripping equipment such as dozers, rippers, bowl scrapers, end-loaders, draglines and—in places—hydraulic monitors, pumps and dredges. A few comments may be of interest in this review, as being indicative of trends.

One company is preparing to offer equipment for overburden disposal which utilizes a conveyor system. Starting at the end of the pit nearest the waste dump, overburden is progressively removed along one side of a fixed conveyor. When excavation starts back on the other side, the conveyors are removed in sections and the underlying waste is removed

Surface stripping of unconsolidated material in extremely cold weather often requires drilling and blasting, and loading the large unwieldy frost chunks is a problem that plagues operators. Frost chunks can now be successfully broken and excavated by heavy duty tractor-rippers. Successively deeper layers are loosened by making repeated passes, lowering the heavy eight-ft ripper tooth mounted at the rear of the tractor, by positive hydraulic-cylinder action. Tests have shown that breaking up frozen ground by this method costs about one half as much as by drilling and blasting. Also, the unit can double in utility jobs when not on a production assignment.

The views of one large manufacturer of stripping equipment are summarized as follows:

"Many stripping operations are, and can be, done with tractor-scraper units. Over a period of two yr productivity was increased over 50 percent due to the development of larger capacity machines and greater horsepower. The wholesale index price on machinery of this type has increased 62 percent over the 1949 price level; however, the average bid price to move a yard of dirt has only gone up about 14 percent. The earthmoving equipment industry has had a major voice in holding down costs. Mining operators are not always aware of this. There are lots of people to be convinced when consideration is given to purchasing new equipment. The equipment manufacturers and distributors are obliged to keep mine operators informed of new developments." A job which they are doing very well.

One major power shovel company has redesigned their standard 20-yd stripping shovel used in the coal industry to one of 11-yd capacity for use in a cement quarry in Ohio. According to the manufacturer it will be the largest shovel used in the cement industry. Major changes in the design were reduction of dipper capacity, increase in boom length from 105 to 160 ft, increase in crowd handle length from about 48 ft to about 67 ft, and increase in the maximum dumping radius from 112 ft-3 in. to 158 ft.

Another manufacturer has on the market a 600-hp rubber tired dozer. The 52-ton dozer has a top speed of 28 mph both forward and reverse. With 600 hp spread across a 14-ft

Sand overburden is stripped hydraulically by remote control monitors at Demerara Bauxite Co. in British Guiana. The sand is washed to a sump and pumped to disposal areas

blade, this versatile machine should furnish a lot of dozing ability as well as push-loading assistance when used behind scrapers.

Drilling

The lively interest in blast hole drilling techniques and equipment continued throughout the year, as evidenced by several well arranged programs at technical society meetings and by numerous articles in the technical press.

Recent years have witnessed a remarkable trend toward the use of rotary blast hole drilling in rocks too hard to attack with drills of this type and bits formerly available.

A tungsten carbide tricone bit has been developed for use in material as hard as taconite. Many studies and tests have been and are being made of the performance of the rotary versus the "down-the-hole" percussion drill, and comparisons with jet piercing are made in extreme cases. Each operation poses its own problems and must be handled individually. In any event, it is safe to say that the churn drill has become obsolescent for all but special applications.

At the C. F. & I. operations in Utah the contractor adapted a down-the-hole drill with carbide-tipped bits, to a rotary rig for use in very hard ore, with gratifying results.

The Minnesota Ore Div. of J. & L. plans to replace as many of its churn drills as possible with 6½-in. combination rotary-percussion drills. Caved underground workings and fractures may prevent or restrict the use of anything but churn drills at the Schley group mines, however.

At its Benson mines in New York state, where hard magnetite and martite is mined, J. & L. is considering a changeover from its present 9½-in. churn drilling to rotary drilling with 7½-in. holes, based upon successful testing with a larger rotary hole (9⅞ in.). At this property down-the-hole drills are used for angle holes in areas of excessive burden, and to trim pit walls.

At Kaiser Steel's Eagle Mountain Iron mine it was found that a rotary with 9⅞-in. bit drilled from four to eight times faster than churn drills. Rotaries are now used exclusively in soft to medium hard ground and down-the-hole drills are used in very hard waste, drilling 16 ft per hr against a former two ft per hr with churn drills.

At National Lead Co.'s ilmenite-magnetite mines, Tahawus, N. Y., down-the-hole drills, with 6½-in. carbide-insert bits completely replaced churn drills during the year. These machines drill at 10 degrees off the vertical, a recent development designed to reduce backbreak. The bits are good for about 1550 ft before resale due to loss of gauge. Savings of 30 percent on drilling costs more than offset the slightly lower production per ft resulting from closer hole spacing.

At the British Canadian mine of Asbestos Corp., Ltd. in Quebec, mobile percussion drills have proven more economical than either churn or rotary drills. One of these large quarry drills capable of drilling 6-in. holes was converted to a dual-mast outfit equipped with two percussion machines. The redesigned unit drilled 220 ft of 3½-in. hole per manshift versus a former 40 ft of 6-in. hole. Coupled with use of AN explosive and a change in drilling pattern, substantially reduced blasting, loading and truck haulage costs resulted.

At National Lead's Magnet Cove mine, a barite pit in Arkansas, a down-the-hole machine using carbide insert bits in 4¾-in. holes was put to work about a year ago, and has resulted in a 30 percent cost reduction including amortization as compared with former churn drills and wagon drills.

At the Frood open pit, the 9-in. carbon steel bits originally used with the electric-driven churn drills averaged 2¼ ft per sharpening. After changing to a nickel alloy steel, SAE4340, heat treated to 235 Brinnell, the footage per sharpening increased to 6½.

The DuPont Co., at its titanium dredging operations in Florida, encounters organic-cemented sands or "hardpans" at random throughout otherwise unconsolidated titaniferous beach sands. These hardpans must be blasted to be dredged efficiently, and recent tests have indicated that 9-in. holes can be drilled 60 ft deep with water-jetted rotary drills at three to four times the rates of penetration of the churn drills currently in use. Nilite has replaced the more costly Nitramite formerly used with equal results at reduced costs.

Jet piercing is in the foreground among methods of drilling hard and very abrasive materials. Originally developed at the Minnesota taconite properties, this method is now used in Michigan jasper iron ores and at nepheline syenite, granite and quartzite quarries. Last year it proved to be the most efficient method of drilling Potsdam sandstone on the St. Lawrence Seaway excavation.

Blasting

There was no let-up in the intense interest of operators in blasting with fertilizer grade ammonium nitrate. This subject was profusely discussed during 1958, and many have benefitted by the wealth of data released. AN explosive has been used in smaller and smaller holes by reason of improved and clever refinements in priming and detonating; and the earlier bugaboo of wet holes becomes less formidable with schemes for pumping and quickly thereafter charging and firing the holes; with various methods of water-proofing or packaging the prills or granular nitrate as the case may be; and with mixed charges of AN and conventional types of dynamite, or bottom loading with the latter and completing the charge in the dry upper portion of the holes with prills.

The modifications of technique are nearly as numerous as the operators that use them, and at this stage of the art, personal preference and perhaps inertia undoubtedly are responsible for some of the vagaries in practice. A trend toward standardization will follow with time, subject always to the variations imposed by Nature. Space does not permit detailed discussion in this review of the numerous combinations and modifications practiced, although we contemplate compiling the wealth of information furnished us by many operators in a later article.

Needless to say, the wide acceptance of cheap fertilizer grade explosives during the past two to four years has been a blow to explosives manufacturers. But with their typical progressive spirit they have "rolled with the punch" and are either entering this market with improved prills or packaged AN, or contributing to the development of optimum priming and detonating supplies, or both. They are developing formulated nitrocarbonitrate blasting agents. These products are made with explosive grade AN and sensitizing and oxygen-balancing materials in order to produce a completely formulated product. This agent, although somewhat higher in price than AN fertilizer, is intended by the manufacturers to give improved results with lower drilling, blasting and digging costs than with regular fertilizer grade AN. The task of the operators of having to mix the blasting agents is eliminated by the use of the formulated mixtures. A water resistant grade is now available for moderate wet hole conditions.

Data on explosives performance expressed in tons broken per lb of powder at some 29 mines selected more or less at random, but fairly representative of the wide range of conditions met with in open pit mining, are summarized in Table I.

Loading

Although not as spectacular as recent improvements in drilling and blasting practice, there was steady progress in the design and efficiency of loading equipment during the year. Controls, transmissions and drives, durability of materials exposed to wear, mobility and versatility of use all felt the impact of engineering research and development by the manufacturers. Here and there larger shovels were purchased or bigger dippers were adapted to existing machines, in efforts to combat the un-

Table I

TYPE AND DUTY OF EXPLOSIVES AT REPRESENTATIVE MINES
S=Soft; M=Medium; H=Hard; Vy=Very

Ore Mined	Mines	Nature of Ground		Principal Explosive Used	POWDER FACTOR, TONS BROKEN PER LB EXPLOSIVE	
		Ore	Waste		Ore	Waste
Iron	A	M to H	H	AN	1.33	4.0
"	B	H to Vy H	H	Dyn some AN	2.4	2.5
"	C	H	H	AN	1.25 to 1.5	
"	D	S to M H	—	AN H ore only	to 8.5	
"	E	H	H	AN; AN + Dyn wet	3.5	—
"	F	H to Vy H	H	AN	4.0	
"	G	Extremely H	None	Mostly AN	1.0	—
Copper	H	M	M	AN	4.13	
"	I	S to M	S to H	AN	5.25	4.22 to 6.23
"	J	S to M	S to M	AN	7.5	
"	K	S to M	S to M	AN	5.0	7.5
"	L	M	Unconsol	AN	4.0	—
"	M	M	M	AN	5.0	
"	N	M to H	S to M	Dyn	2.6	
"	O	M	M	AN	7.0	
"	P	S to M	S to M	AN	7.35	
"	Q	S to M	S to M	AN	10.0	
Uranium	R	M H	M H to H	Dyn	2.63	2.5
"	S	M	S & M	AN	2.50	2.50 to 3.75
Bauxite	T	S	—	75% AN 25% Dyn	3.0	—
"	U	S	—	Dyn Some AN	9.0	—
Asbestos	V	S	M	Dyn & AN	8.0	
"	W	S	M	AN	Explosive cost 2 cents per ton	
Dolomite	X	M	—	Dyn	—	
Nepheline Syenite	Y	H	—	70% AN 30% Dyn	2.25	—
Limestone & Cement Rock	Z	M	M to H	AN	3.3 to 4.0	
"	AA	M S	—	AN Dry Dyn Wet	Explosive cost 6 cents per ton	
Barite	AB	S to M H	S to M H	80% AN 20% Dyn (Wet)	2.5	2.25
Gypsum	AC	S	Vy H	Mostly AN Waste Bag Powder-Ore		Approx. 2.0

ending spiral of wage inflation. Bigger front-end loaders have appeared. Larger and more efficient dozers, motor patrols and other auxiliary equipment are going into service. Improved wear-resistant alloys are used, and better steels for equipment working in severe cold climates are available.

However, the smaller units of all types of mining equipment are still needed and used, for certain special conditions such as selective mining, adverse road conditions, or for normal operations in the great number of small mines.

Mobile diesel-electric generating units large enough to supply power for two moderately large shovels continued in use at some mines where public utility power is not cheap. At Anaconda's Jackpile Uranium Mine in New Mexico, where some 45,000 tons of combined ore and waste is moved per day, the two stripping shovels (a 6-yd and a 5-yd) are served by two 500 kva diesel generator units housed in mobile trailers, an arrangement which functions very satisfactorily. At this mine, individual generators are used with each shovel rather than serve both from one power source. This minimizes transmission distances when the shovels are widely separated, and obviates any chance of two shovels being idled simultaneously by breakdown of one power unit.

One manufacturer of shovel dippers

Table II

RANGE OF PRODUCTION RATES, MEN EMPLOYED, BENCH HEIGHTS, STRIPPING RATIOS AND UNIT PERFORMANCE OF LABOR AT 66 OPEN PIT MINES AND QUARRIES DURING 1958

Mines	Average Daily Mine Production (tons ore)			Average Number of Employees Charged to Mining			Bank Heights (feet)			Stripping Ratios (tons waste per ton ore)			Average Tons Ore Per Manshift			Average Tons Total Material Per Manshift		
	All Mines	Smallest Mine	Largest Mine	All Mines	Smallest Mine	Largest Mine	Average All Mines	Min	Max	Average All Mines	Min	Max	All Mines	Min	Max	All Mines	Min	Max
24 iron mines U. S. & Canada	6,300	1,700	45,000	117	50	868	32.6	15.0	55.0	1.14	0.20	2.67	53.8	40.8	100.0	115.1	62.2	323.7
14 copper mines U, S., Canada, Mexico and Chile	22,785	400	91,200	534	65	2,117	47.3	25.0	90.0	1.64	0.45	3.20	42.7	23.0	173.0	112.7	80.5	325.9
9 uranium mines U, S., & Canada (in part Estimated)	978	90	4366	42	5	252	—	4.0	80.0	6.09	2.00	78.00	23.5	15.0	91.6	166.5	22.2	179.5
5 asbestos mines Canada	4061	2683	5500	106	18	200	56.7	45.0	75.0	1.53	1.00	2.05	38.3	27.5	149.5	96.9	80.0	149.5
14 cement & rock Quarries, Bauxite, Phosphate, Gypsum & Vermiculite Pits U.S., Canada & South America	4057	333	12,195	64	12	200	51.0	15.0	140.0	1.98	None	5.40	63.4	27.8	115.1	188.9	28.0	427.4

NOTE: The foregoing figures are incomplete, and are based almost entirely upon data supplied the authors directly by the mining companies, with some gaps filled from reliable published sources. The purpose of this tabulation is to illustrate the range of conditions and production in open pit mining, and in no sense do these figures represent complete statistics for the industry.

American Smelting and Refining Company's two pits in the Silver Bell, Ariz., area are four miles apart. Moving heavy equipment between them is accomplished with techniques such as the one shown. A 160-ton shovel can be moved in 2½ hours over this company owned road

notes the trend to larger bucket sizes. Operations that formerly used 5 and 6-yd dippers are now using 8½ and 9-yd. This ties in closely with the increase in truck size, larger crushing installations, and the dire need to cut down the amount of manpower per ton of ore processed.

Haulage and Transportation

The general trends in drilling and loading equipment apply also to haulage equipment. Competition is keen, and designers are working hard to furnish more efficient haulage equipment. Tires are being improved along with trucks. This is a fruitful field for such efforts, since tire costs constitute the largest single item of expense. The higher tread types carrying around 25 percent more rubber for about 15 percent more first cost, became popular two or three yr ago, and more so as time goes on.

Most truck pits have hauls of a mile or two on waste and ¼ mile to one or two miles on ore—although hauls up to three or four miles are not rare. Adverse grades against loads are usually held at seven or eight percent maximum, with local greater pitches on new drop-cuts, etc. Most operators hold the grades against the loads on waste dumps between two and four percent.

In cases where very long truck hauls are necessary, experience has justified the construction and maintenance of good hard-surfaced high-speed roads.

A novel new rear dump pit truck, having a short turning radius, unusually good visibility, good ratio of pay-load to empty weight, body mounting on nitrogen gas-filled cylinders, and simplified lubrication arrangements, was under test during the year. At nine western iron mines, tests showed this truck to be more maneuverable and faster than conventional designs, an experience shared at a large uranium pit in the southwest. Other factors such as fuel consumption, tire life and durability are still under test.

Kaiser Steel's Eagle Mt. Mine is getting good service on waste hauls with its semi-trailer units having unique dumping action and 64-ton capacity. Excellent road maintenance contributes to good truck operation at Eagle Mountain.

The similarity in quality and performance and the narrow range of choice between different makes, were illustrated by studies at Lone Star Steel Company's iron mines in Texas, which are now nearing completion in connection with a changeover from 15-ton to 30-ton units. Ninety day tests involving three different makes indicated that any of these trucks would double the present production rate.

Many operators are turbo-charging their older trucks to attain more power and speed. New intermediate size trucks are now on the market. Some have radical new designs which have to be proven and are now undergoing field tests.

Riverside Cement Co. at its Oro Grande Quarry solved the braking problem formerly experienced with 30-ton side-dump trucks on its loaded haul downgrade (six percent) by switching from trucks to Tournarockers with Allison automatic transmissions.

At National Lead's Magnet Cove barite mine, where the loads are hauled one mile against a nine percent grade, some 22-ton rear-dump trucks have straight transmissions and some have torquematic. The maintenance costs of the latter type are considerably greater than for the straight transmissions. Despite more efficient operating techniques, the increasing hardness of the ore and the greater length of the uphill haul due to deepening the pit are resulting in higher costs of operation. Serious thought is being given to installation of an inclined skipway.

A new 27-ton rear-dump truck has been developed by a major truck manufacturer conforming with the trend toward larger units, better performance and greater use of torque converter and power shift type transmissions. This unit compared to a 22-ton truck produces 16 tph more production. Three of these units will do the work of four 22-ton trucks, with a 20 percent reduction in cost.

Another manufacturer has an off-the-highway truck designed to haul 40 tons. A new frame, bogie, planetary drive and brakes were designed to take care of the load distribution.

Measures to reduce haulage-road maintenance and to minimize the effects of dusty and muddy conditions have been interesting. Lignin sulfonate was used at Chino and in other districts with gratifying results. Regular black-topping is used, particularly where hauls are longer, or in special circumstances such as Asarco's Silver Bell operation where, in addition to a long haul, a good road is necessary to permit rapid interchange of mobile equipment between two pits.

At Reynolds bauxite operation in Arkansas, experiments have recently been conducted to reduce the costs of periodic replacements of road surfaces, dust-allaying measures, grading and ditch-cleaning by sealing the road surfaces. Two test sections of road surface, 0.7 and 1.0 mile in length were given a penetrating oil coat followed by a thin layer of hot asphalt with a 15 percent latex additive, after which chat and sand were applied uniformly to give a total seal thickness of ¼ to ½ in. To date, both sections have withstood constant traffic loads of 50 tons at 30 mph very well, with minor repairs in two small areas having excessive clay in the underlying surface. The latex prohibits brittleness in the seal thereby eliminating checking and scabbing; dust conditions resulting in rapid engine wear have been reduced and tire and body maintenance have benefited by the readily drained, smooth, uniform road surface.

The use of water for dust control is often required, and in the Southwest where water is scarce this is a costly item. The Santa Rita mine of the Kennecott Copper Corp. in Hurley, N. M., has partially licked this

problem by spraying a dilute solution of lignin sulfonate, a by-product of pulp paper manufacturing, on the roads. This eliminates 80 percent to 90 percent of the dust problems and serves also to seal the top surface against the weather. A study shows that use of this solution saves 11,000,000 gallons of water per year.

To our knowledge there were no new pits in the United States with rail haulage in 1958; the last large installation of this type in the country being one of the taconite pits on the Mesabi Range. Rail haulage will be used at the new Toquepala Mine in Peru. Some of the larger copper pits converted to heavier locomotives, and it appears that the versatility and freedom from power-transmission nuisances inherent in the use of diesel-electric locomotives will lead to their increasing popularity.

Increasing depths at some pits make skip hoisting or crusher-conveyer installations attractive. Where material must be elevated 400 ft or more, the trend is toward inclined skipways. Several units custom made by the National Iron Co. of Duluth, Minn., are in use at Minnesota iron mines. Pima has a 22-ton skip hoist. Anaconda is considering a 50-ton unit at the Berkeley pit and Kennecott's Santa Rita mine plans to install a 40-ton skip in 1959. Bagdad Copper has also considered an incline skip. Inclined skips will be installed by J & L at the Schley-Pettit property, Gilbert, Minn., to meet the problem of caves and waste-fill areas resulting from underground mining operations in former years.

This system of elevating ore from a deep pit on 25 to 45 degrees (and steeper) slopes in skips is the answer in many deep and narrow mines. Level truck hauls in the pit to loading pockets keep trucking costs at a minimum. The skips are designed to match truck sizes so that one truck load will equal one skip load. Another big advantage is that the skipway may be lengthed as the pit is deepened. Cost experience has shown that at some mines skip haulage costs are 10 to 50 percent less than with other methods.

Conveyor belt haulage came in for considerable attention during the year, with some interesting developments.

One manufacturer is preparing to offer equipment for overburden disposal by means of a conveyer system. The basic plan contemplates starting at the end of the pit nearest the waste dump and by dragline and conveyors remove the overburden progressively along one side of a fixed conveyor. After the turn is made at the far end of the pit and excavation starts back on the other side, the fixed conveyors will be shortened on retreat and the material in the space formerly occupied by them will be removed.

A rubber company has developed a belt which in its three-ply form is claimed to be equal in strength to the conventional six-ply 32 oz cotton duck. This thinner belt allows the use of smaller terminal pulleys resulting in a substantial savings in installation costs and power consumption. Also this belt can resist an impact load five times that of the conventional five-ply belt, and can withstand a load of 345 lb compared with 95 lb for a five-ply belt.

Transportation of over 20,000,000 tons of gravel over a 2-mile conveyor system for the construction of a 13 mile road bed across Great Salt Lake for the Southern Pacific Railroad, is a project providing much food for thought by open pit mine operators. The 54-in. belt with five transfer points covers a distance of 11,900 ft. The belt travels at a speed of 800-880 fpm and was designed for capacity of 4200 tph of earth, sand and clay including boulders crushed to eight in. At this capacity, the write-off cost is estimated at $.05 per ton moved on the job; an actual operating cost of $.02 per ton is reported.

This method of overburden disposal may compete favorably with truck haulage over moderately long distances. In some cases even the transportation of ore for considerable distances by conveyor belts is practical, as witness the bauxite conveyors in Jamaica, among others. A large ore handling conveyor is being planned for one of the iron ore developments in India. The application of conveyors to the removal of overburden at some of the Minnesota iron mines, where they are used with large draglines and portable loading hoppers, is well known to the industry.

Another manufacturer, who has made large semi-portable conveyor systems for stripping, believes that rope-suspended conveyors, used successfully in underground coal mines, may have important future applications in surface stripping and mining. A number of competing manufacturers are working on developments in this field.

Service and Maintenance

It is now quite unusual to note an open pit operation with substantial output that does not have also a systematic program of preventive maintenance. Many smaller operators, furthermore, are just as conscious of maintenance as the big fellows, and do just as good a job.

In the program followed by Lone Star Steel in Texas, oil changes and engine overhauls are based upon the results of analysis of oil samples, taken from each machine every 24 hours and analyzed for viscosity, asphaltic material, acidity, sediment and water, and metallic particles. A well designed field service truck is used at these operations.

At Asbestos Corporation's British Canadian Mine, Black Lake, Quebec, the 14 Euclid trucks (7TD and 8TD models) are operated under rigid maintenance schedules, which, except for daily greasing, are determined by fuel consumed rather than by recorded tachometer "hours," miles or the like. Definite maintenance procedures are followed after every 750, 2000, 4000, 8000, 16,000 and 32,000 gallons of fuel consumed per unit. This interesting and logically conceived idea no doubt is based upon the theory that fuel consumed is proportional to actual power delivered or work done, and is thereby a better yardstick of mechanical wear than total revolutions or miles which in themselves have no relation to loads carried, road grades encountered, speeds, etc.

Unique Problems and Practices

International Nickels' Frood open pit, having reached its planned depth of 600 ft, was mining the remaining ore from bottom-benches on a one-shift basis during the first three quarters of 1958. Due to decreasing pit diameter, the eight percent grade pit roads (two miles to crushing plant) were connected by a haulage tunnel in the footwall, on a five percent grade, between the lower and upper ramp roads. This scheme obviated substantial waste stripping.

A step toward automation by the Riverside Cement Co. was the purchase of an RW-300 Digital Control Computer for installation next spring at its Oro Grande, Calif., plant. Costing about $130,000, it will guide the operation of a completely mechanized blending facility, will provide information to control quarrying and stockpiling operations which involve complex calculations related to composition, quantities, and points of origin of thousands of tons of rock and other raw materials. The decision followed a six months' application study and is expected to result in more production of more uniform quality cement at lower cost. Also at this plant, installation next year of a 60-in. A. C. gyratory crusher near the quarry, feeding the plant by a conveyor belt, will enable future expansion as well as maintaining the present rate of production with ten shifts per week instead of 15.

Uranium mining continued to challenge the operators with problems of grade control, sampling and assaying methods and shortcuts, erratic and spotty distribution of ore lenses and seams, and possibilities for maximum recovery with minimum dilution by open-pitting as opposed to incomplete recovery by underground mining, to say nothing of the non-recovery of ore in the thinner seams overlying a main orebody whose existence might go unsuspected, or which would be individually too small to justify development entry from underground workings.

Special methods of blast hole sampling, engineering control of blasting for optimum selective loading, and pit scheduling to facilitate the all-important blending operations so essential in minimizing fluctuations in millhead grade and in other metallurgical characteristics such as hydrocarbon and lime contents, were developed some years ago at Anaconda's Jackpile Mine in New Mexico; these matters have been and are still the subject of unremitting research and experimentation by the mine staff, with cooperation in special situations from the electronics experts of the Eberline Instrument Co.

Similar problems and their solution, as well as an excellent description of the earlier history, development and present operation of Gunnar Mines' Beaverlodge uranium mine on Lake Athabasca, are fully described in a comprehensive brochure entitled "Gunnar Mines Ltd." which was printed for the use of delegates to the Sixth Commonwealth Mining and Metallurgical Congress in Canada in September of 1957. During 1958 this operation went forward on schedule, with only minor changes in practice insofar as the open pit was concerned. Due to the proximity of the lake and increasing waste ratios with depth, the proportion of underground to pit production will increase on a methodical schedule until the pit ore is exhausted.

It is interesting to observe the variations in operating methods and equipment in situations where the central objectives are the same, but the operating conditions different. We find bulldozers and wheeled scrapers, working down grade on the dip of the bedded deposits, skimming off and piling up phosphate rock in Idaho, to be loaded from the piles into trucks by small shovels. Add some water, and some depression below ground level, and you approach the conditions confronting the Billiton Bauxite Mines in Surinam. Equatorial downpours sometimes fill the shallow pits with water, and although they are pumped out it is impossible to alleviate the slop remaining in the pit bottoms, which are 50 ft or more below sea level. The management has worked out a combination of drag-line shovels (four and five-yd buckets) and rear-dump Tournapulls which work very well, considering the two or three ft of "slurry" in which the equipment frequently must operate. "C" models hauling 22 tons are being supplanted by the 35-ton "B" models.

One of the problems of blasting with toe holes is that the new solid face is left standing at a steeper angle than desired. A crew of bank trimmers is necessary to bar down loose material. A mechanical bank trimmer has been devised at Bingham Canyon by using a bulldozer fitted with a Hyster unit which operates like a drag line excavator. A toothed rake is attached to the end of the cable, reaching over the bank and dragging back up the face to tear loose any hanging rock in its path. Two men and this machine will cover several times the area and do a cleaner job than a crew of men working by hand.

In arid sections of the country where dust is a problem, maintenance costs are high. One California mining company had the problem of dust getting into the electrical control system and moving gears of their B-E 110B-shovel. This problem was licked when the Reese Blowpipe Co. designed a filter system and pressurized the cab on the shovel.

In some operations where high summer temperatures are prevalent special problems in the care of machinery are noted. Asarco's Silver Bell mine is using heat exchangers on the hydraulic systems of their rotary drills.

Rubber tired bulldozers continued to demonstrate their versatility for effective cleanup close to railroad tracks in pits using rail haulage and were increasingly used in auxiliary car switching jobs, due to the ease with which they can cross track rails and switches or operate on railroad ties without damage to the trackage.

The two pits in the Silver Bell area, the Oxide and El Tiro, some four miles apart, present a problem of moving heavy equipment. Silver Bell has solved this problem by using a 75-ton low-bed trailer, which is 10 ft wide and is equipped with outriggers which add an additional two ft for moving a 40-R Bucyrus Erie drill. This move can be made with the loss of only one hr of drilling time. To move a 160-ton shovel, two 75-ton trailers are used in parallel. This move can be made in the space of 2½ hr.

A new inexpensive device which screws on the valve stem of each truck tire and shows immediately if the tire has had a drop in air pressure is now on the market. This indicator was designed to save costly time both on the road and in the shop and also will relieve the problem of truck tire wear. This product is called "No-Lo Tire Pressure Indicator."

A new type radiator known as the "Withnell," for use on trucks or industrial engines is now being marketed. It consists of header sheets, tubes, grommets, tube stay and rubber gaskets. The initial cost is approximately $500 which is comparable to the cost of conventional radiators. Field repairs can be made by simply using a special pry tool to depress the rubber grommets, slide a tube out and insert a new one, in a matter of a few minutes. If extra tubes are not available, slide out the leaking tube and block off the openings, and the radiator will still function. In one case a truck was involved in an accident necessitating the straightening out and replacement of a dozen tubes. Had this been a regular type radiator, the entire core would have had to be replaced at considerable cost and loss of time. One operator in the Southwest states that he has not had a failure up to 3500 operating hr as compared to an average of 750 hr for the ordinary radiator.

Pit Design

Several operating companies, as well as engineering schools and others were actively engaged in continued research in the related fields of soil and rock mechanics and geology applied to pit design during 1958. Increasing depths of pit workings and the trend toward higher stripping ratios render such investigations valuable. Whether we will be able to apply mathematical formulae based upon physical data with true precision and without some faint-hearted hedging is doubtful; but anything that will tend to reduce the large safety factors now considered prudent in selection of pit slopes will be a forward step fraught with substantial cost savings.

Stripping ratios are, of course, a function of many economic factors, sometimes quite complex. Space does not permit a lengthy discussion of this fundamental subject here, but reference is made to Table II which gives among other things the range of stripping ratios and bank heights at a number of mines, grouped by product.

Labor Duty

A very close comparison of labor efficiency from mine to mine is not feasible, in a review of this type, due to different accounting methods and policies in distributing overhead and indirect labor, supervision, etc. However, the groupings of mines by product and the tabulated figures of average, minimum and maximum tons per manshift, as given in Table II should be of interest to those who are familiar with operating conditions. For example, the high stripping ratios in uranium pit mining—nearly six times as great as for iron ore—are reflected by much lower output of ore per manshift, even though average tons of total material per man is about 50 percent greater than for iron. If equal sized equipment were used it would be at least double, one might surmise. Yet comparing the nature of overburden, and the divergent types and sizes of equipment used to handle it, it is seen that generalizations are unsafe. In the last analysis, one man produces about twice as much iron ore per shift as he does uranium ore, which is worth about twice as much per ton at the mine as the former.

New Developments in Prospect Abroad

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(Continued on page 85)

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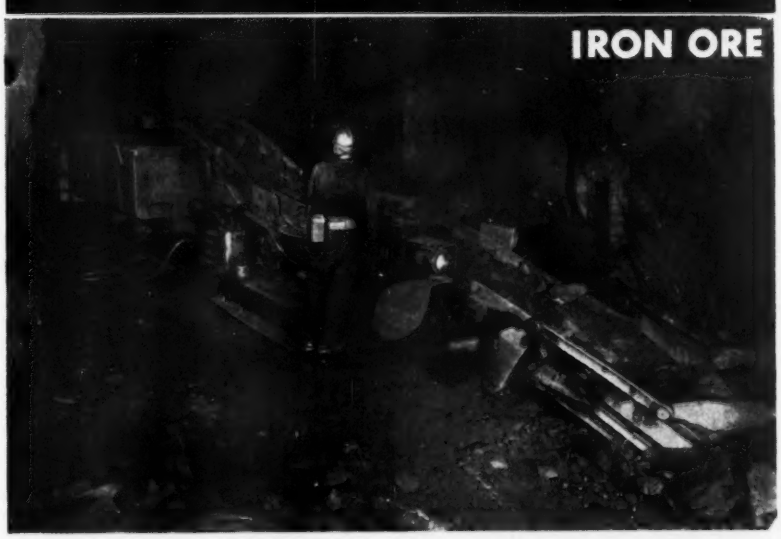

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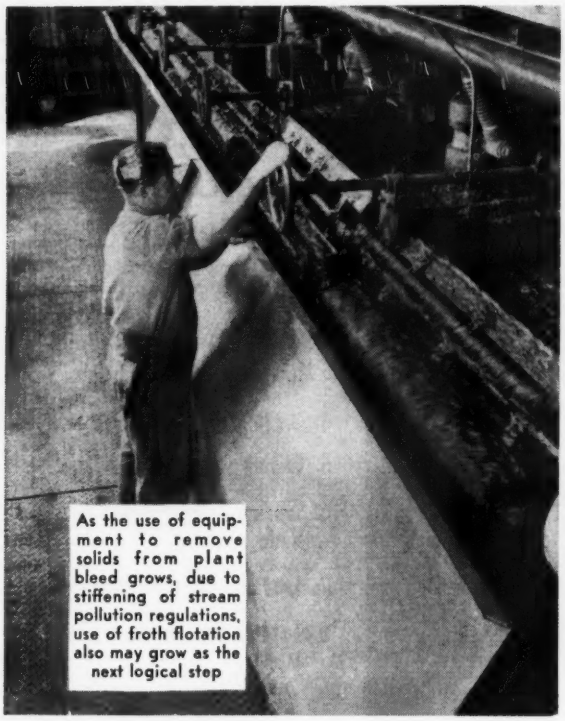


As the use of equipment to remove solids from plant bleed grows, due to stiffening of stream pollution regulations, use of froth flotation also may grow as the next logical step

Close control pays off in plant efficiency and uniformity of products

COAL PREPARATION

Stiffer competition for the past year's decreased coal market has placed added emphasis on quality and dependable sizing

By J. N. SHUPE
Director of Preparation Control
General Coal Co.

THE vital role of preparation in the modern coal producing company is recognized generally today by progressive management. Customers, present and potential, are the unseen consultants at the planning table. Thus, the modern preparation plant must be both efficient and flexible to allow the company to win and keep its share of today's markets. Men responsible for preparation are recognized as full members of the production team. With this status preparation men can do a better job.

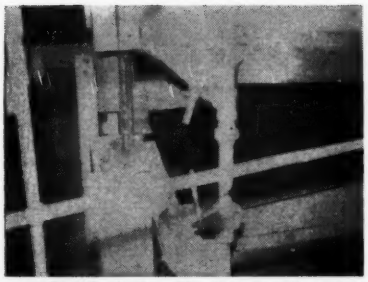
Accelerated activity of the Coal Preparation Committee of the American Mining Congress illustrates the growing emphasis on efficient preparation. Increased attendance and lively discussions at the several meetings have indicated strong interest in improving various phases of coal preparation. Subjects studied and discussed include importance of water clarification to plant efficiency, stream pollution, flocculation, faster coal testing procedures, thermal drying, magnetite recovery and precautions to avoid plant start-up troubles. The work of this committee promises to exert an increasing influence in the industry.

Elements of Modern Plant

Stiffer competition for 1958's decreased markets increased emphasis on quality and dependable sizing. Considerable new preparation capacity was added during the year consisting of both large and small new plants and a number of additions to existing plants. Most of the additions to existing plants provided facilities for cleaning and thermal drying of fine coal. Increased pressure to keep plant bleed solids out of streams also resulted in additions to existing plants and incorporation of necessary water clarification or bleed water disposal into designs for new plants.

Typical of the elements most often included in a modern preparation plant are those listed below. They compose the flow sheet of a plant put in operation late in the year.

1. Adequate fresh water supply at required pressure
2. Raw coal top sizing, including hand picking and crushing of plus six-in. coal
3. Raw 6 in. by 0 storage in three 500-ton bins with two vibrating feeders under each bin, each feeder capable of delivering half of the plant feed
4. Baum-type jig; screening, crushing and recirculating of plus ¼-in. middlings; ¼-in. by 0 screened from No. 3 elevator product recleaned on high capacity refuse discharge type double-deck tables
5. Sizing and dewatering of plus ¼-in. clean coal on vibrating screens
6. Dewatering of minus ¼-in. coal with combination of vibrating screens, centrifugal dryers, cyclone thickeners and disc-type vacuum filter
7. Thermal drying of ¼ in. by 0 in fluid bed dryers
8. Refuse circuit, including dewatering jig refuse in elevators and table refuse on vibrating screen, caking underflow of refuse cyclones and static thickener on disc-type filter, and using aerial tram for refuse disposal.
9. Closed water circuit with respect to solids achieved with the cyclone thickeners, vacuum filters



Double-deck table in operation

and static thickener with pond for emergencies

10. Bins, blending and loading facilities for clean coal, including two-stage adjustable crusher for reducing the largest grade if desired.

Several types of equipment are used in up-to-date plants to provide the general elements illustrated above. Some of the equipment generally used and some apparent trends in the various phases of preparation are discussed below.

Plant Layout and Storage Facilities

Emphasis is on convenient location of equipment for minimum operating and maintenance manpower. Fine coal plants as large as 150 tph have been built recently which require only one operator and part-time services of one maintenance man to deliver clean, mechanically dewatered coal.

Adequate raw coal storage is being recognized as a necessity to make the mine and cleaning plant independent of each other for several hours at least, to permit continuous operation of one without the other. Raw coal blending facilities to reduce fluctuations in quality of plant feed are considered important in some cases. Notable recent installations include single bins in excess of 1000 tons capacity, multiple bins of similar total capacity and outside storage piles of several thousands of tons with efficient blending and reclaiming facilities. Raw coal storage facilities will probably be added to existing plants in the future.

Clean coal storage for flexibility in filling orders and for blending purposes was used in 1958 and the practice is likely to spread. Keen competition has stimulated the blending of sizes to obtain "tailor-made" products. Treatment for allaying dust and for freeze proofing has been practised by many operators.

Screening

Both vibrating and shaker screens were installed in new plants during the year for sizing and dewatering. Several of the new eight-ft wide vibrating screens are in service. Modified resonance screens were also installed. A screen centrifuge was applied in 1958 to final dewatering of stoker size coal. Screening people are working to improve vibrating screen efficiency and to reduce power requirements. Future plants may use less space and less power for screening. Plans are now being made to test a new high speed vibrating screen which may move the practical limits of wet screening into finer mesh sizes, possibly simplifying fine coal classification.

Cleaning

The majority of the larger plants built in 1958 use Baum-type jigs as the primary washer, usually with tables or secondary jigs for recleaning fines or middlings. Several heavy medium plants using multiple units for large capacity were built in 1958 and a large number of small and medium capacity heavy medium washers were installed as was the case in 1957. Several manufacturers reported success in reducing magnetite consumption. Very high capacity jigs with total washing widths of ten ft have been introduced, one model providing an integral rewash unit.

The double-deck tables introduced in 1957 were popular in 1958 with over 100 tables being shipped for installation during the year in new plants and additions to existing plants. Some interest was shown in fine coal jigs, and development work is under way on heavy medium cyclone cleaning of coal in the approximate size range from ½ in. to 48 mesh. A number of successful fine coal plants using heavy medium cyclone cleaning of ⅜ in. by 48 mesh, and froth flotation of 48 mesh by 0, were reported in Europe. An American company has been licensed to handle Dutch State Mines heavy medium cycloning process for fine coal in the United States.

Froth Flotation

Several batteries of froth flotation cells were put in operation during the year and their success promises to stimulate interest in this means of cleaning the very fine sizes. Froth flotation techniques are improving and some success has been reported in cleaning 48-mesh by 0 slurries containing 60-70 percent minus 325-mesh solids.

As the use of equipment to remove solids from plant bleed grows, due to stiffening of stream pollution regulations, use of froth flotation also may grow as the next logical step. If the "closing" of the circuit requires thickening and filtering equipment, addition of froth flotation may become feasible if the value of the coal thus recovered is sufficient.

As noted above, coal cleaning costs have been increased in many cases by the necessity for clarifying bleed water. In some cases this has involved only pumping to impounding areas. In other cases static thickeners and vacuum filters have been required.

J. N. Shupe's early experience was with Stonega Coke & Coal Co. as chemist and later as head of the company's testing department. He joined General Coal Co. in 1952 as preparation engineer and was promoted to director of Preparation Control in 1954. In addition, he has been serving on Committee D-5 of ASTM for several years.

Flocculation has been used in some cases to obtain effluent clear enough for admission to the streams. On the bright side of the water clarification picture are several reports from operators of large cleaning plants that very low solids content in circulating water is beneficial in connection with quality of products and capacity of the plants.

Mechanical Dewatering of Fines and Thermal Drying

A popular circuit in 1958 included vibrating screen classification, cyclone thickening and dewatering with screen-type centrifuges and agitating-type disc filters. Solid bowl centrifuges also are used widely.

Thermal drying of fines is increasing along with the steady increase in washing of fines. Considerable numbers of fine coal thermal dryers of several types were installed or contracted for in 1958.

Quality Controls

Use of automatic controls, including gravity and bin-level controls, has increased. Systematic sampling and testing of the various intermediate products as well as final products is practiced rather generally in the complex preparation plants of today. Several manufacturers offer automatic samplers consistent with ASTM standards and they are incorporated into the design of many new plants. Such close control pays off in plant efficiency and uniformity of products.

A Look Into the Future

The year 1958 has been one of progress in quality and efficiency of coal preparation. Equipment and circuits now under study and development may make the plant of the future smaller per ton hour of capacity. The pressure for clarified plant effluent may accelerate interest in cleaning and recovering the finest sizes of coal now lost in plant bleed. One of the fine coal cleaning circuits of the future probably will include the heavy medium cyclone-froth flotation combination, which is enjoying increased use in Europe. Constant efforts to improve product quality and to lower preparation costs will strengthen coal's position in the markets of the future.

The second of two deck plates, each weighing 645 tons, is shown being placed on the world's largest steel island, located seven miles off the coast of Louisiana. The sections form the floor of the mining plant at Freeport Sulphur Company's Grand Isle project, the first offshore mines. The buildings to the right of the mining plant are used to house employes. Further along the structure is the heliport, and at the far end is the drilling and production platform

Sulphur

By CHARLES A. WIGHT
President
Freeport Sulphur Co.

Last year was one of paradoxes for the United States' sulphur industry. Production was substantially below the 1957 level, yet domestic consumption held up relatively well in the face of the recession. The United States was, at the same time, the largest exporter and the largest importer of elemental sulphur in the world. Despite an apparent oversupply, new sources of sulphur were tapped or were under development

Production engineers are shown completing a model of directional piping for sulphur production wells at Grand Isle. All wells will be directionally drilled so that the well heads can be concentrated in a small area while the bottom holes can be scattered as widely as 800 feet horizontally from their surface location. At least 80 bottom-hole locations will be available from each of the two production platforms

PRELIMINARY data indicate that 1958 sulphur output from all sources in the U.S. amounted to 6,200,000 long tons, down 800,000 tons from 1957. A small decline in demand and some increase in imports had their effect, but the drop was due primarily to a cutback in stockpiling of Frasch sulphur. Whereas producers' stocks of mined sulphur rose considerably in 1957, there was no significant change in these above-ground reserves in 1958.

Indicated Frasch production was about 4,650,000 tons, compared with 5,490,000 tons in 1957. Of the balance of the output, 630,000 tons represented elemental sulphur recovered from refinery gases and sour natural gas; 400,000 tons sulphur contained in pyrites; and 520,000 tons sulphur in various forms from other sources. One change in these figures from those of 1957 was a 120,000-ton increase in the output of recovered sulphur; several new projects came on stream to increase this expanding source of sulphur.

Elected to his present post last October, Charles A. Wight joined Freeport Sulphur Co. in 1948 as chairman of the executive committee. He previously had been a vice president of Bankers Trust Co. Wight is a director of Madison Fund, Inc., McGraw Hill Publishing Co. and Grumman Aircraft Engineering Corp.

Consumption of sulphur in the United States during the year was off a few percentage points. Toward the end of 1958 the industry experienced an increase in demand, but the increase was not sufficient to bring the annual rate to the level achieved in the preceding year.

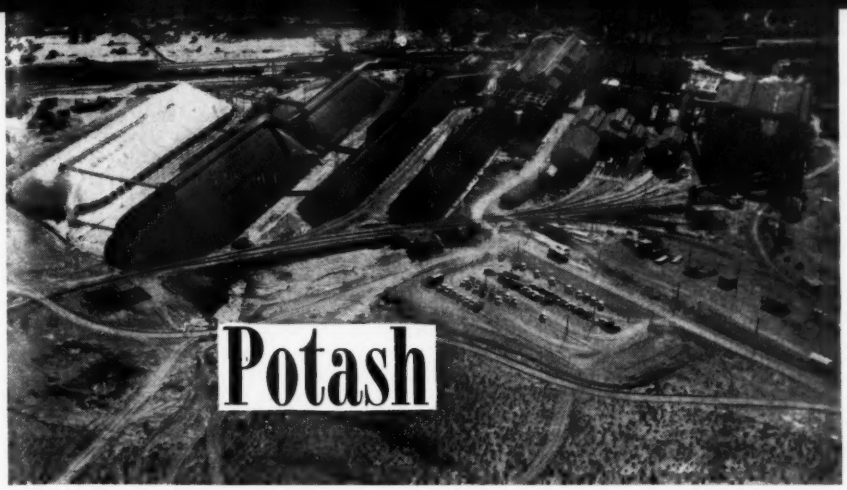
The decline reflected the lower output of such major consuming industries as steel, rubber and textiles. However, the relatively good year experienced by the phosphate fertilizer industry and segments of the chemicals industry, two of the largest sulphur consumers, helped to bolster the consumption figure.

Both Exports and Imports Increase

A particularly bright spot for producers was the increase in exports. Shipments abroad reached an estimated 1,575,000 tons, which is slightly higher than the 1,562,000 tons shipped in 1957, and only 75,000 tons below the record exported in 1956.

This record is a further indication of the trend in foreign markets toward brimstone instead of pyrites as a source of sulphur. Almost all of the new sulphuric acid plants constructed overseas of which we have record were designed to burn brim-

(Continued on page 82)



Potash

About 85 percent of all American potash is mined near Carlsbad, N. M., from deposits 1000 ft below surface. This area has been in continuous production since United States Potash Co., now a division of United States Borax & Chemical Corp., started operations in 1931. At the present time there are seven companies with interests in potash production in the Carlsbad area. Pictured is the refinery of U. S. Potash

The American market now requires eight times the amount of potash that it did in 1931. Nonetheless, production has far outstripped demand, and the domestic potash industry is confronted with excessive stocks of refined potash, low prices, and increased imports. Under the specter of high grade deposits under development in Canada, even stiffer competition appears inevitable

By HORACE M. ALBRIGHT

Consultant-Director
U. S. Borax & Chemical Corp.

THE potash industry in the United States in 1958, like the old gray mare, "ain't what she used to be."

It is in trouble due to over-production, reduction of prices to a 20-year low, rising costs, strikes, increased importations from several European countries, including Russia. Furthermore, a rich body of potash ore has been discovered in the Province of Saskatchewan, Canada, and if it can be profitably mined it is likely to seriously affect the American domestic potash production.

The industry is essentially a mining business, although the California producer—American Potash & Chemical Corp.—makes potash from a brine pumped from Searles Lake; and another company — Bonneville, Ltd. — makes it from a brine pumped from underground sources near Wendover on the Utah-Nevada boundary.

Change in Government Policy Allows Tremendous Expansion

About 85 percent of all American potash is mined near Carlsbad, N. M., from beds about 1000 feet below the surface in mines that have been built and operated since 1930. Prior to this, the American market was largely supplied from German and French mines. Foreign interests held a near-monopoly of potash distribution in our country.

In 1931, production was begun in the New Mexico mine of United States Potash Co., now a division of United States Borax & Chemical Corp. This company's refinery was completed in September, 1932. Competition followed almost immediately when the Potash Company of America, with headquarters in Denver, developed a mine and began the production of muriate of potash by the floatation process. By 1940, a third company was ready to mine and refine potash materials and its property was shortly acquired by International Minerals & Chemical Corp. of Chicago.

Thus, when the war began, there were four producers in the industry—the three mentioned above and American Potash and Chemical. They expanded rapidly and were successful in meeting the requirements of the American farmer and the chemical industry all through the war and afterwards when demand increased substantially.

At Trona, Calif., American Potash & Chemical owned a considerable part of Searles Lake, and it had several mineral leases from the Federal Government. The producers at Carlsbad all operated under mineral leases. Relations with the Federal land agencies were always excellent and the author does not think any potash mining company ever had any complaint as to how the mineral leasing laws were administered. Under amended legislation, the leases were effective indefinitely as long as their terms and conditions were complied with.

In 1934, the Secretary of the Interior ordered that no more prospecting permits for potash be issued as a step in the conservation of the potash resource. This was a sound order. It meant no more leases, no new mines. This order was in effect ten years.

Suddenly, in 1944, the Secretary reversed this policy and invited applications for prospecting permits under amended mineral leasing act rules, thus throwing the public domain wide open. Hundreds of applications for permits poured in and soon more potash mines were under development. First came Duval Sulphur & Potash Co. with headquarters in Houston, Tex. Next came Southwest Potash Corp., a wholly-owned subsidiary of American Metal Co., now American Metal Climax Co. Finally, National Potash Co. entered the field. This company is owned by Freeport Sulphur Co. and Pittsburgh Consolidation Coal Corp. The Farm Chemical Resources Development Corp., organized by the National Farmers Union of Denver, assembled a group of prospecting permits, explored for potash, found a bed deemed commercial in content, and sank one shaft. Phillips Petroleum Co. and Kerr-McGee Corp. both acquired stock in this company, so the newspapers reported. This seventh Carlsbad company has not completed its plants, and will not be in production in the early future.

Delhi-Taylor Oil Co. has discovered a potash deposit in southern Utah and is reported to be contemplating the development of a mine.

Horace Marden Albright has had such an impressive career that it is impossible to do him justice in this space. He was graduated from University of California in 1912 and received a degree from Georgetown University in 1914. Albright began his career as an instructor of economics, but soon became active in the field of conservation. He was director of the National Park Service from 1929 to 1933. In 1933 Albright became vice president and general manager of U. S. Potash Co., retaining those positions until 1946 when he became president and general manager. He is now consultant-director of U. S. Borax & Chemical Corp., of which U. S. Potash Co. is now a division. He is also a director of the American Mining Congress.

Several New Mexico producers have secured rights to explore for potash in Saskatchewan, and Potash Company of America, under a provincial lease, has just completed a shaft to a depth of 3450 feet and has constructed a refinery. The property is near Saskatoon, and is nearly ready to produce marketable potash materials. International Minerals & Chemical Corp. is engaged in sinking a shaft several hundred miles eastward of Saskatoon.

Meanwhile, the foreign producers have recovered from the disasters of the war, have enlarged their plants, have suplied their own growing markets, and have extended their exports to the United States and Canada where they sell potash at prices below those of the American producers. In 1957, two shiploads of potash reached our shores from Russia. The foreign producers have advantages of lower labor and other costs, and favorable transportation rates for shipments to American ports.

Overproduction and Imports Create Problems

While potash is used both in agriculture and industry, more than 90 percent of all domestic production and imports is destined each year for agriculture where it is used in the fertilization of land, mixed of course with phosphate, nitrogen and minor elements. In 1931, when potash mining began in this country at Carlsbad, 275,390 tons of K_2O were used in the American market, which includes Canada. By 1939, it had reached 483,400 tons K_2O. Demand for potash increased rapidly during and after the war, and by 1957 it reached 2,231,407 tons K_2O, including 219,903 tons K_2O imported from European sources. American potash exported in 1957 amounted to 129,517 tons K_2O.

But production far outstripped demand, and now we find agriculture increasing its use of mineral fertilizers only two percent per year, with a corresponding increase in requirements. At the end of 1957, stocks of refined potash at the producing plants reached the all-time high of over 900,000 tons —over 500,000 tons K_2O—and these were still very high when the fertilizer season ended in June. The result—vacation and other economy shut-downs to aid in reducing inventories. Two of the companies have also been subjected to strikes over contract changes sought by the companies in efforts to reduce costs, and a general strike affecting all the potash mines in New Mexico is threatened over wage demands.

What can be done for potash? Well, economic advisers of mining and chemical industries can advise against developing any more mines. Both the United States and Canadian Governments could clamp down a tight restriction against more mineral leases in support of a strong conservation policy. Even this unlikely program, if adopted, would be locking the barn door after the horse is stolen!

Then our Congress, which just made improvements in the anti-dumping laws could enact still stronger legislation along lines we suggested and supported without success. Such legislation could have the effect of limiting of imports, especially from East Germany and Russia.

It is worth repeating here that potash has never had any protection whatever, and that the development of all our producing properities has been accomplished without Government aid of any kind, before, during, or after the war.

Stockpiling of potash has never been proposed and would not be practicable.

It would apear that hope for the industry—forelorn as it may be—lies in the short-range possibility of prices returning to a level consistent with rising costs, and the long-range increase in agricultural demand inherent in population growth bringing rise in food requirements, plus new outlets in export trade, especially in the Orient and some Latin American countries.

SULPHUR *(Continued from page 80)*

stone. The reason behind this is, of course, the low price of such sulphur and the assurance of a permanent supply made possible not only by the expanding Frasch industry in the United States and Mexico but also by the new sour gas recovery projects at Lacq in France and in Alberta, Canada.

To meet more effectively the increased competition abroad from foreign sources of sulphur, the four U.S. Frasch producers during the year formed the Sulphur Export Corp. to sell their sulphur outside the North American continent. The jointly owned company was created under the terms of the Webb-Pomerene Act, which permits companies within an industry to form a single organization to transact their business abroad.

Imports were again up, although proportionately much less than in 1957. Incoming shipments of Mexican sulphur increased about 110,000 tons to a total of 600,000 tons, while imports of Canadian recovered sulphur and pyrites showed little change.

SULPHUR IN THE UNITED STATES
(in thousands of long tons)

Form of Sulphur	1956	1957	1958 (estimated)
Brimstone			
Frasch process	6425	5490	4650
From gases	465	510	630
Other Sulphur			
Pyrites	430	435	400
Other forms and sources	500	565	520
Total	7820	7000	6200
EXPORTS			
Total	1651	1562	1575
IMPORTS			
Total	387	669	760
FRASCH MINE STOCKS			
Total	3583	4039	4050

Important New Developments Boost Capacity

Twelve Frasch-process mines were in operation in the United States during the year, including a new mine opened in May by Texas Gulf Sulphur Co. at Fannet, Texas. Texas Gulf remained the largest producer, followed by Freeport Sulphur Co., Jefferson Lake Sulphur Co., and Duval Sulphur and Potash Co.

Two new salt dome deposits are under development, both projects of Freeport. The largest is Grand Isle, a discovery of major magnitude located off the Louisiana coast in 50 feet of water, seven miles from the mainland. The second, known as Lake Pelto, is located a few miles away in the shallow, partially protected water along the coast.

Six new projects to recover sulphur from refinery gas or sour natural gas were completed during the year or are under construction in the U.S. The estimated new capacity is on the order of 100,000 tons annually. The major projects, both for the recovery of sulphur from refinery gas, are those of Socony Mobil Oil Co., at Paulsboro, N. J., with a capacity of 42,000 tons a year, and of Magnolia Petroleum Co., Beaumont, Texas, with 24,500 tons annually.

Elsewhere in the free world, Texas International Sulphur Co. is constructing a Frasch plant—Mexico's fourth —at Texistepec with an announced capacity of 1000 tons per day. In Canada, four new facilities or expansions are under way or completed which will have a total new capacity of more than 300,000 tons. The companies and the sources used are: Laurentide Chemical and Sulphur Co., refinery gas; British-American Oil Co. and Texas Gulf Sulphur, natural gas; Steelman Gas Ltd., flare gas from oil production.

In France, the Societe Nationale des Petroles d'Aquitaine added 280,000 tons of new annual capacity at its facilities which recover sulphur from sour natural gas at Lacq. This expansion is part of the company's announced program to increase production to 1,300,000 tons by the early 1960's.

Some half dozen other projects located in Great Britain, Taiwan, Japan, Australia and South Africa will, when completed, add a total of about 75,00 tons of additional annual capacity.

The price of sulphur in the U.S. and that of Frasch sulphur in world markets remained at a depressed point throughout the year despite numerous printed rumors of an impending increase. Competitive factors kept the quoted U.S. price for both domestic and export shipments at $25 a long ton f.o.b. port.

Light Metals

Can Russia stifle the growth of the light metals industry?

By WALTER L. RICE
President
Reynolds Mining Corp.

THE light metals of commercial significance today are aluminum, magnesium, titanium, beryllium and zirconium. Of these, aluminum is by far the largest industry, with a current rate of production and consumption roughly 30 times greater than that of the other four metals combined.

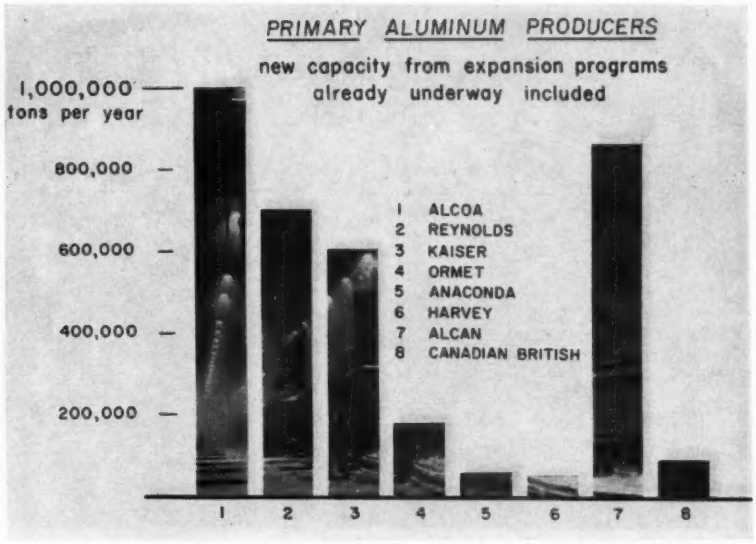
Magnesium, Titanium Down; Beryllium and Zirconium Up

Even though relatively small in volume, the other four light metals are vital in many areas of today's complex technology, and all of them have definite potential for growth. The author's business is aluminum, and he is not an expert on magnesium, titanium, beryllium and zirconium. Nevertheless, he shall attempt to give you some highlights of what has been happening to these metals.

Two of them, magnesium and titanium, have suffered sharp declines in demand, due chiefly to an altered national defense picture. The other two, beryllium and zirconium, are currently enjoying a rapid growth which comes largely from the increasing number of nuclear power plants being built.

Magnesium production, after increasing 415 percent from 1950 through 1957, has declined sharply.

Titanium is a metal which several years ago held the bright promise of rapid growth, and the production of titanium sponge skyrocketed from 75 tons in 1950 to 17,500 tons in 1957. Capacity was likewise increased to about 36,000 tons today. But sponge producers are reportedly operating at only 25 to 30 percent of capacity, or an annual rate of about 11,000 tons. A sharp cutback in aircraft procurement is the main reason given for titanium's slump. Defense planning today is placing greater stress on missiles and less on airplanes. However, because titanium does have the capability of maintaining its physical properties at extremely high temperatures, its use in missiles is expected to grow.



A brighter situation exists in beryllium. Production of this extremely light and very strong metal is soaring, probably because of its usefulness in the atomic energy field. Its low neutron cross section makes it an ideal reflector or moderator in reactors. One of its other principal uses is as an alloying ingredient in copper. It has been predicted that the present annual consumption of about 4400 tons of beryllium may increase as much as tenfold in the next ten years.

Zirconium, another light, strong metal, has attracted little attention until recently. From an annual output of only 250 tons in 1956, the zirconium industry has increased its present and planned capacity to about 3000 tons, partially because of its use in nuclear reactors.

Aluminum Companies Boost Capacity

Aluminum, like most other metal industries, has been adversely affected by the recent recession. The term "recent" recession is used, because it is obvious that business in general is rapidly improving.

In the first quarter of this year, the industry shipped aluminum at an annual rate of 1,500,000 tons, equivalent to 6,000,000 tons of bauxite, or roughly 25 percent below the level of a year earlier. The industry actually hit bottom about the beginning of the year, preceding by several months the low point of the steel industry.

A gradual recovery set in, and by the second quarter, shipments were at a rate of 1,750,000 tons. By the end of the year, demand is expected to have regained or even exceeded its 1957 level of 1,900,000 tons. However, the industry has been adding new capacity this year as part of an expansion program which began about the time of the last shortage of aluminum in 1955.

All of you are familiar with the dramatic growth of the aluminum industry in the United States and Canada. Just prior to World War II the United States had only one producer of primary aluminum. The capacity was 165,000 tons per year. Today North American aluminum is being produced by eight companies, six in the United States and two in Canada, with a combined capacity of 2,850,000 tons per year.

The largest of the United States companies is still the Aluminum Company of America with a present capacity of 792,500 tons, and with announced plans for construction of an additional 207,500 tons, which will bring their capacity to 1,000,000 tons per year in about two years. The most interesting of the announced ex-

A native of Minneapolis, Walter L. Rice was graduated from the University of Minnesota and the Harvard Law School. He practiced law in New York and was later special assistant to the U. S. Attorney General, where he served as chief counsel in the prosecution of major antitrust and criminal cases.

Rice joined Reynolds in 1941. He holds many offices in the company including those of president, Reynolds Mining Corp.; vice president, Reynolds Metals Co., and president, Reynolds Jamaica Mines, Ltd.

In addition to other business and civic activities, Rice is a member of the Natural Resources Committee of the U. S. Chamber of Commerce and a member of the Aluminum Industry Advisory Committee, Office of Minerals Mobilization, Department of the Interior.

A half-million dollar walking dragline, which handles about 11 tons every 40 seconds, is used to mine bauxite in Arkansas. Its 180-foot boom permits the dragline to move waste and ore a total of 360 feet. Electric powered, the machine has its own substation

pansions of Alcoa is a single 150,000-ton plant to be located near Evansville, Ind., to use power generated entirely from coal in a captive 300,000 kw power plant.

Reynolds Metals Co. has grown from a single reduction plant at Listerhill, Ala., with a capacity of 30,000 tons completed in 1941 to its present capacity of 601,000 tons. With the completion in 1959 of a new 100,000-ton plant at Massena, N. Y., based on power from the St. Lawrence Development, Reynolds' total capacity will become 701,000 tons.

Kaiser Aluminum and Chemical Corp. produced no aluminum pig until after World War II, but has a capacity today of about 537,000 tons. When Kaiser's new plant at Ravenswood, W. Va., is completed, its capacity will be 609,500 tons.

The Anaconda Co. has been operating a 60,000-ton reduction plant in Montana since 1955. This plant is based on Bonneville power.

A recent entry into the aluminum field is Ormet Co., a combination of Olin Mathieson Chemical Corp. and Revere Copper and Brass Co. This firm has just started a plant at Omal, Ohio, which will be producing at its capacity of 180,000 tons by the end of this year.

Another newcomer to the primary aluminum field is the Harvey Aluminum Co. which has just begun operation of a 54,000-ton reduction plant at The Dalles, Ore., using Bonneville power.

The Aluminum Company of Canada has grown into a very large producer. This firm has a present day capacity of 776,000 tons, of which 367,000 tons is concentrated in the largest single aluminum reduction plant in the world at Arvida, Quebec. This firm has announced an expansion of its Kitimat, British Columbia, plant which will bring the firm's total capacity to 866,000 tons.

The second Canadian firm is a newcomer, Canadian British Aluminum, Ltd., which has just started partial operation of a 90,000-ton reduction plant at Baie Comeau, Quebec.

When all of the above announced expansions have been completed, the total North American primary aluminum capacity will be 3,560,500 tons, of which 2,604,500 tons will be in the United States.

Russians Use Increased Capacity as Cold War Weapon

Of special interest to the aluminum industry today is the potential of our newest competitor in the world aluminum market, Russia and her satellites. The growth of aluminum capacity in the U. S. S. R. has been even more dramatic than in America. Russian production of aluminum in 1939 was about 60,000 tons, and this has grown to about 590,000 tons, plus 190,000 tons in satellite countries, including East Germany, Hungary, Poland, Czechoslovakia and Red China. Announced expansion plans of the U. S. S. R. and the satellite countries indicate a probable capacity in 1961 of 1,430,000 short tons, of which about 1,110,000 tons will be in the U. S. S. R. itself.

The most striking plan announced by Russia is to construct the largest reduction plant in the world at Krasnojarsk in Siberia, with a capacity believed to be greater than 400,000 short tons per year. This plant will be one of a giant complex starting with hydro-electric power and an alumina plant which will consume bauxite and the mineral nepheline (sodium aluminum silicate) from nearby mines.

Russia is using her growing industrial might to demoralize the free markets of the West. Although we do not yet have direct importations of Russian metal into the United States, our industry has felt the impact of Russian raids on the British and European markets. Sporadic sales of a relatively small tonnage—only 35,000 tons—sold primarily in England, have been deliberately priced at seven to eight percent under the market and timed to disrupt the industry at its weakest points. This has reflected itself in exports of fabricated aluminum to the American market at prices 20 percent below market.

There can be little doubt that the spectacular two-cent price reduction in March 1958, in the face of increasing wages and costs was largely the result of Soviet manipulation. Even today when Russia has temporarily withdrawn from the market, it announces a London price seven percent below the new reduced prices.

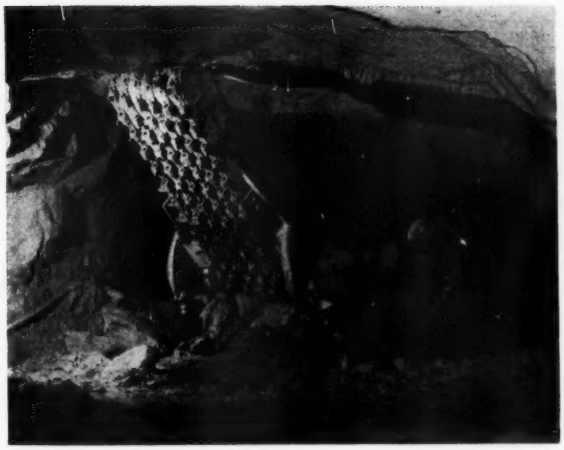
We desperately need a national policy and vigorous measures to protect legitimate American industry from such sporadic attacks. If we do not act promptly, Nikita Khrushchev will make good a portion of his boast to destroy the capitalistic nations by economic warfare.

Soviet tactics serve the dual purpose of generating foreign currency and disrupting competitive industries in the Western world. Russian pricing of aluminum bears no relationship to costs in a competitive system. As our industry advised the State Department on July 14, 1958, Russia was exacting a 28 percent premium above world prices for the aluminum it sold during the 1955 scarcity.

Late in 1957 when the Western aluminum market was receding, Russia offered aluminum to England, Germany and Belgium at a two-cent discount below Western prices. Soviet domestic prices were maintained at a rate 139 percent higher.

When the United States Government called for competitive bids on 250,000 pounds of aluminum plate, the lowest bidder—20 percent below the average of all domestic bids—represented a Belgian mill purchasing Russian aluminum. The order was awarded to the Russian metal.

The Russians boast about their natural resources—hydroelectric power on the Volga and Ob Rivers and nephaline-syenite containing both alumina and soda. They use vast amounts of slave labor and semi-slave labor. The cost of constructing a power dam or transporting raw materials thousands of miles across the Ural mountains does not have the same meaning to them that it does to an American businessman. Depre-



The tremendous growth of the aluminum industry, coupled with highly competitive pricing of the metal, demands that bauxite mining methods be most efficient. Mechanized mining, characterized by equipment such as this continuous mining machine, is standard procedure at Reynolds Mining Corporation's underground operation in central Arkansas

ciation and interest are not recognized costs in Russia.

The Soviet Government can subsidize any commodity that may be selected for hit-and-run attacks on the Western markets. When aluminum is vulnerable it will be selected. Zinc, tin and platinum have already been singled out. If Russian economic warfare goes unchecked, don't be surprised if they some day select copper, lead or steel either to generate foreign currency in a particular market or to stimulate a recession at the most opportune time.

Committee to Study International Controls Needed

Vital American mineral industries require protection not only from Russian raids, but also from dumping by friendly producing countries. Our aluminum industry pays an average hourly wage of $2.50. Manufacturing industries in the United States in 1957 paid $2.07, whereas in the United Kingdom the average was 62c, in France 39c, in West Germany 48c and even in Canada only $1.63.

The United States cannot depend upon foreign producers in times of emergency. When we have an oversupply they open the flood gates; when we are in short supply, imports decline. This was demonstrated in World War II and again in the Korean War when imports declined drastically, and the United States had to take emergency steps to expand industry in the United States.

What should be done to protect competitive American industry from glutting an oversupplied market, sporadic raids and deliberate economic warfare, without unduly upsetting the reciprocal trade policy of our Government? The author proposes that a dynamic committee be set up to study the problem and present concrete recommendations to the State and Commerce Departments consistent with the mineral policy adopted by the American Mining Congress in September 1958. The Committee should consider various methods of setting up international controls to avoid excess importation of aluminum and other vital metals into countries already overburdened with an oversupply. The import quotas on lead and zinc are a step in the right direction. The author sees no reason why the same principles should not be applied now to aluminum and other competitive domestic industries which have ample capacity and skilled workers hungry to supply American requirements. Our industry is grounded on sound economics and it has a brilliant future, but it can remain strong only if protected against Soviet economic warfare and subsidies to foreign exporters granted by friendly Governments in order to generate dollar exchange. Healthy development of our fabricated products and markets cannot proceed without reasonable protection.

The aluminum producers believe that a protective import formula should be worked out based on normal import years.

With respect to exports the aluminum industry advocates that the State, Commerce and Interior Departments encourage exports of domestic metal, particularly to underdeveloped countries, by including aluminum in the Trade and Aid programs.

Aluminum producers are confident that measures will be adopted in cooperation with industry and friendly nations so that excess production will not go into markets already over-supplied by regular sources.

Aluminum Industry May Reach 10,000,000 Tons by 1975

On this assumption our industry faces a healthy development of its end products and a spectacular future growth. Reynolds' Planning Department forecasts doubling of the U. S. industry from 1955 to 1965 and quadrupling—to 10,000,000 tons—by 1975. Our forecast includes more aluminum for all types of transportation, cars, trucks, railroads, ships, housing, skyscrapers, appliances and packaging.

It does not include the large potential use of light metals in missiles and rockets. We are now emerging into the space age. Man-made satellites are in orbit and tremendous rockets are being readied for shots at the moon. We can only dimly perceive the nature of future progress in this field, and certainly cannot guess at its pace. But of this we can be sure —that man must use light metals to overcome gravity and lift himself into space. These amazing rocket vehicles will be shining evidence that this is indeed the age of light metals.

OPEN PIT MINING

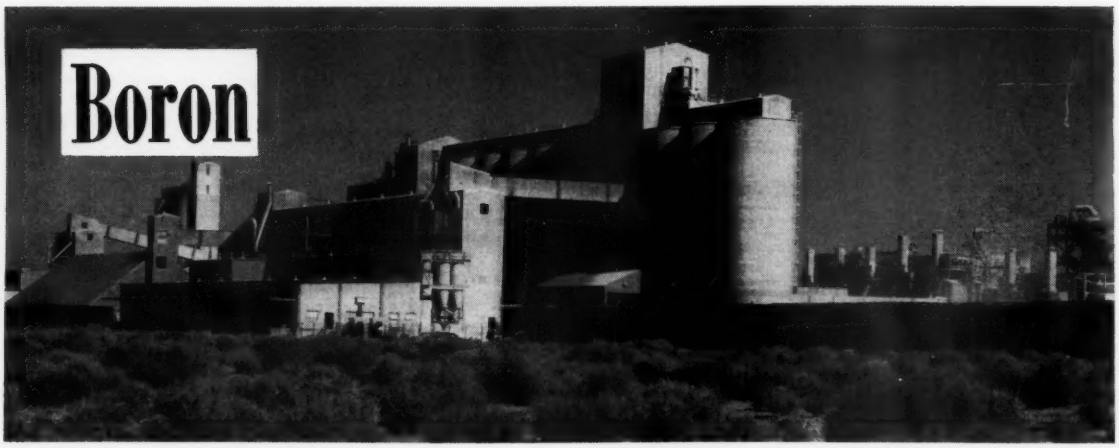
(Continued from page 76)

ments, a few random items regarding major projects are submitted as a matter of general interest.

The liberalization of export exchange policy by the Brazilian government led to the negotiation of large deals for iron-ore mining rights by the M. A. Hanna Co., Cleveland-Cliffs, Cyrus Eaton interests, Kaiser Industries and a number of European firms. A large concession in Liberia was obtained by a group of German companies. Also in Liberia a new open pit at Cape Mount will increase Liberian Mining Company's annual iron ore output from 2,500,000 to 7,500,000 tons per yr; Liberian American Swedish Minerals Co. plans an operation of similar capacity at Nimba, whence a 250-mile railway will be built to transport ore to the coast. Plans were announced for construction of a mining plant and belt-loading facilities at Barsua, Orissa Province, India, 225 miles southwest of Calcutta, where an open pit will furnish ore for a 1,000,000 ton per year steel plant at Rourkela.

We hope that this review will serve to outline at least in a general way what transpired in open pit mining during 1958, and to indicate the trend of future developments. Since no one man, however active, could possibly keep abreast of all facets of such a broad and geographically dispersed field, we mailed questionnaires to some 200 operators and suppliers. The response was almost overwhelming and provided a wealth of data which greatly augmented our own information and experience. The problem has been to decide what to omit, and if any of those who were so generous with facts and figures fail to note specific reference to their contributions in this review it is only because the space available could be stretched no further. We take this occasion to express our sincere thanks to those who furnished information about their operations or products, and whose cooperation has made the preparation of this review a pleasure.

Boron



By J. F. CORKILL

Vice President and General Manager
Pacific Coast Borax Company Division
U. S. Borax and Chemical Corp.

* Emphasis on research
* Production expanding
* Future applications unlimited

BORON has often been referred to as the wonder element of the twentieth century. In a speech dedicating the boron fuel plant to be operated by Callery Chemical Co., Muskogee, Okla., when it goes on line next November, Rear Admiral R. E. Dixon, chief of the Navy's Bureau of Aeronautics, stated: "This fuel will enable American air power to maintain the ascendency necessary to guarantee continuation of the democratic way of life to the peoples of the free world."

California Supplies 90 Percent of Free World's Requirements

There have been many changes and significant developments since that day in 1881 when borate was discovered in Death Valley, Calif.

Between 1881 and 1959 borate producers have made great strides. While some borax had been produced in California and Nevada in prior years, the discoveries in Death Valley really marked the beginning of this great industry in California. It was here that the famous 20 Mule Teams had their origin and started their treks carrying wagons of borax from Death Valley to railhead at Mojave, Calif. This 20 Mule Team has come to be one of the best known trademarks not only in America, but throughout the world. When borax was discovered in Death Valley in 1881, the U. S. Bureau of Mines reported annual production in terms of borax of about 1000 tons. At the turn of the century this had increased to 12,000 tons; in 1925—67,000 tons; in 1950—523,000 tons and for 1958 it is estimated that production will be nearly a million tons. Not only have these deposits in California supplied the entire requirements of the United States, but they are presently supplying about 90 percent of those of the entire free world.

There are three principal U. S. A. producers of borates or borax, all operating in California within a radius of some 60 miles. In order of productive capacity, they are United States Borax & Chemical Corp., American Potash & Chemical Corp. and Stauffer Chemical Co. (formerly West End Chemical Co.).

During the period since the end of World War I there have been three very significant developments in borate production in California:

1. The development and successful processing of Searles Lake brines by American Potash & Chemical and West End Chemical. While American Potash had made some quantities of borax in prior years, large tonnage production began in 1923. West End—now Stauffer—started producing a few years later.
2. Discovery and development of the vast borate ore bodies in the Kramer District by U. S. Borax & Chemical early in 1926. At this time all mining was done by conventional underground methods, and a dry processing plant was used to concentrate the ores.
3. Finally, the completion of U. S. Borax & Chemical's open pit mine in late 1956. This operation involved not only the opening of this huge pit, necessitating the removal of some 10,000,000 tons of overburden, but construction of a new $20,000,000 plant in which to concentrate as well as refine the ores. The old room and pillar mining operations were highly mechanical and efficient but the company concluded that with the increased demands for borates it should recover all of the ore, rather than the 25 odd percent which it was doing by the old methods. This also gave the company an additional 30 per cent refining capacity. The new plant has been built on a very large site to provide such further expansion as may be required and, as a matter of fact, the company is already having to consider expansion of certain facilities.

Nearly Everything You See or Use Contains Boron

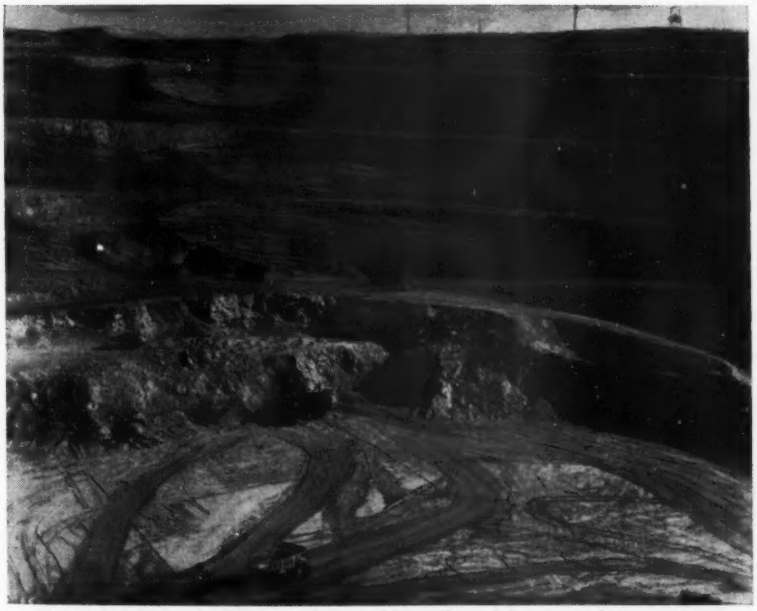
During this span of years, 1881-1958, when demands were continually increasing, it is of interest to examine some of the important uses for these boron products. It should be explained here that the term boron is loosely used. Strictly defined it is an element—not a true metal but often considered as one due to its chemical activity. The element is never found free in nature. When the term is used in this article, it will refer to boron's many compounds including refined borax, boric acid and various other borates. Among these uses are the increased requirements of the glass industry for the production of a wide variety of borosilicate glasses, including laboratory and industrial glassware; cooking ware; sealed beam headlights of which most new automobiles now have four; fibreglas, which has such a multitude of uses, including insulation, textiles and reinforced plastic; poreclain enamel—the ceramic coating which appears on refrigerators, stoves and other household appliances, as well as on the exterior building walls of steel and aluminum; in most antifreezes as a corrosion inhibitor; as a herbicide in killing weeds which are so troublesome to railroads, highways and various industrial installations; as a fertilizer material adding the element so necessary for healthy plant growth. Borates have certain fire retardant properties which make them useful in a number of products for the building industry. One of U. S. Borax & Chemical's new borates, namely, Firebrake, has been most effective in con-

trolling forest fires. This is most important in the Western states where a new technique has been developed of dropping borate slurry by airplane on inaccessible mountain areas. These new methods of attacking and controlling forest fires have materially reduced the tremendous losses—particularly in the Western states. This product may have very interesting possibilities in preventing and controlling mine fires, and it is presently being tested for these applications. It is used in welding, brazing and fluxing and in the refining of precious metals. It is used in soaps and detergents, also in a large group of pharmaceuticals and cosmetics. In addition, there are a great number of other uses for boron products and they are used by nearly every industry that one can imagine. Nearly everything you see or use from birth until death contains this material in one form or another.

Research Opens New Vistas

These are some of the day-to-day uses which will expand as the population increases and as the standard of living improves. The number of housing starts appear to be increasing and this means a definite increase in consumption of boron products. Furthermore, the United States is the major free world supplier of boron products and exports take some 40 percent of present production. The foreign demands, while lagging behind those in America, should keep step in a comparative way as their standards of living improve. It is really some of the future uses for boron compounds which are so exciting and which have received such widespread attention during the past few years.

Boron is the only non-metallic element with less than four electrons in its outer shell, which accounts for its versatility in behaving as both a metal and non-metal. In addition, this "electron deficiency" is a unique and tremendous asset in that it allows boron compounds to complex or react with a large variety of chemicals of almost infinite scope. As a result, a great host of organic boron compounds have emerged from the research facilities of the three boron producers, as well as from research laboratories of other companies. Many of these compounds are being tested for a wide variety of applications. One which has reached commercial use is the gasoline additive made by U. S. Borax & Chemical under license from Standard Oil of Ohio and presently being used in California by Richfield Oil Co., by SOHIO in the Midwest and D-X Sunray in the Southwest. Boron gasoline will also soon be marketed in several foreign countries. Another organic boron compound is one of the starting materials for the high-energy fuel program; butyl borate is used as a slow neutron capturer in the atomic submarines. One of U. S. Borax & Chemical's special products was used in the new Submarine *Triton* which was recently launched. Sodium tetraphenyl boron is a precipitant for potassium and the alkali borate glycol condensation products are beginning to be used as brake fluid additives.



The United States is the major free world supplier of boron products, exporting some 40 percent of present production

Elemental boron is being manufactured in pilot plant quantities and is likewise being tested for a number of possible uses. This product, like certain other borates, has application as a neutron absorber around certain types of atomic installations. Elemental boron has a very high heat of combustion and is also used in flares, ignitors, etc.

Inorganic boron polymers and plastics for use in high temperature fields have extremely interesting possibilities. These have great interest to the Department of Defense due to their requirements for new materials that will withstand temperatures upwards of 1000° F in missile and aircraft applications. Present day polymers based on organic-carbon compounds are unstable at these high temperatures but theory predicts that inorganic materials containing little or no carbon will be thermally stable. U. S. Borax & Chemical was recently awarded a substantial contract by the Air Force to do research in this field and also to study the chemistry of new solid rocket propellant components.

Solid Boron Fuels May Some Day Largely Replace Today's Fuels

Among a host of other new boron products, some of which are presently manufactured and used commercially, are boron carbide, boron nitride, the metal borides, boron halides, such as boron trifluoride, boron tribromide and boron trichloride. This latter product has very interesting possibilities as an intermediate for the building of other chemical products. It is presently being manufactured in commercial quantities as an intermediate for the production of boron fuels. U. S. Borax & Chemical has recently entered into a joint research project with Dow Chemical Co. in order to engage in further work on boron trichloride. Sodium borohydride is being made in ever increasing quantities. While the commercial production of these two products is largely limited to use as intermediates for boron fuels, they also have most interesting industrial possibilities. In addition, work is being done on borozoles (compounds of boron and nitrogen) and perhaps most important of all the boron-hydrogen combinations.

The boron based fuels are certainly

J. Frederick Corkill is a third generation "Borax Company" man, both his father and grandfather having held responsible positions with Pacific Coast Borax Co. for many years. He joined the company in California in 1935 and later went to New York as vice president in charge of sales. He held that position until his appointment as vice president and general manager of Pacific Coast Borax Company Division of U. S. Borax & Chemical Corp. With his broad knowledge of the industry, it is particularly appropriate that Corkill author this year's review of boron.

one of the most interesting and surely the most publicized of the newer uses. While a great deal of the work to date has been done on the liquid boron jet fuels for air breathing engines, there appears to be interesting possibilities for solid boron fuels for missiles. It has been stated that within several years boron or some similar type solid fuel may largely replace those presently being used. The boron fuels are said to possess a combination of advantages such as high-energy content per unit volume and per unit weight which makes possible higher speeds and extended range.

The initial boron fuel program was started by the Navy in 1952 under the appropriate name "Project ZIP." Two companies, namely, Olin-Mathieson and Callery Chemical Co., a division of Mine Safety Appliance, were given development contracts. The program was joined by the Air Force in 1955. After very considerable research had been done, estimated to have cost many millions of dollars, certain chemical break-throughs were made which made these fuels practical. Olin-Mathieson is presently operating a $4,500,000 plant for the Navy, as well as a $5,500,000 company-owned plant where the output goes to the Department of Defense. It also is constructing a larger plant costing some $40,000,000 to be operated by the Air Force. All of these plants are in the Niagara Falls area. Metal Hydrides is presently manufacturing an intermediate which is supplied to one of the Olin-Mathieson fuel plants. Callery recently completed its own company-owned plant costing some $4,000,000 at Lawrence, Kan., and is building a plant which it will operate for the Navy at Muskogee, Okla., costing some $35,000,000. Despite these huge expenditures, it is said that these are hardly more than large scale pilot plants. U. S. Borax & Chemical, and it is understood the other producers as well, have been awarded substantial boric acid contracts to supply these plants and deliveries have already started.

In addition, it has been announced the AFN, Inc., a corporation formed by American Potash, Food Machinery and National Distillers, has a contract to develop a high-energy fuel process for the Air Force. Stauffer has joined with Aerojet to do work in this field.

Still other companies have combined to conduct research and development work—either government sponsored or on their own, in the high-energy boron fuel field. A few of these are:

1. Gulf Oil Company's purchase of stock in Callery Chemical Co.

2. The Thiokol-Callery arrangement for research and development. Subsequently, Thiokol purchased Reaction Motors and most recently Thiokol and Callery have been joined by General Motors in a research and development program.

B-70 Chemical Bomber Will Have Speed of Mach 3

It should be emphasized that a great deal of the information regarding these chemical fuels and the so-called hardware in which they will operate is highly classified. Recent published articles in "Aviation Week" however speculate that:

1. Contracts have been awarded for the development of the B-70 chemical bomber. This airplane would have a range of over 7000 miles flying at an altitude of 70,000 ft at Mach 3—using boron based fuels.

2. Production contracts for the F-108 long-range interceptor have been issued contemplating delivery of planes beginning in 1960. These would have a range of some 1100 miles with a similar speed and altitude of the B-70.

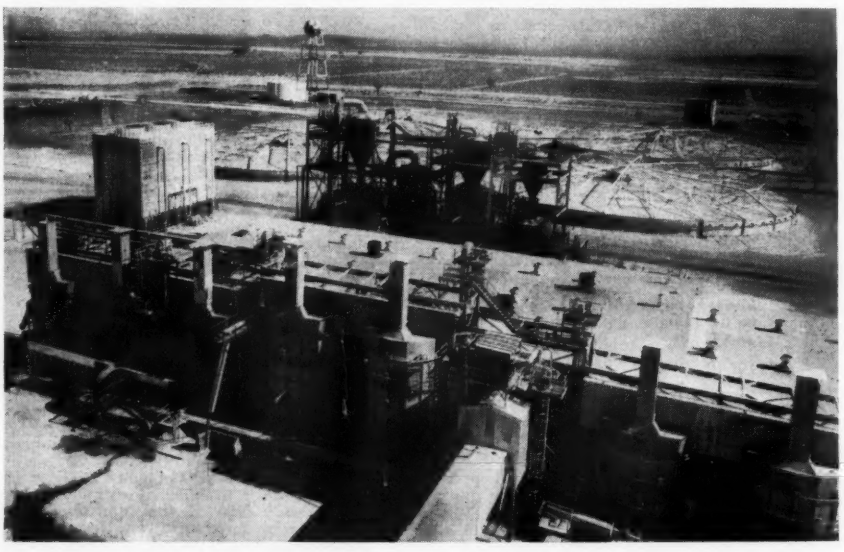
3. General Electric is well along on design of the engine—the X-279 to power these planes. This would operate on boron fuel as well as the conventional jet fuel.

4. Several major transport builders are beginning preliminary research on these Mach 3 aircraft. A recent press release indicated that Douglas Aircraft Co. was actively seeking a sub-contract on the B-70.

The boron requirements of the two fuel plants presently being constructed will be small in relation to total borax production, but these can increase. It has been suggested by one of the Arthur D. Little engineers in a speech to the American Institute of Mining Engineers—and this may be pure guesswork—that if the boron fuels prove successful—to keep 30 bombers flying a year—using boron fuel only 25 percent of the time would take about 45 percent of current U. S. A. borate production. While these estimates are admittedly speculative, they do point up quite vividly the boron potentialities for the future. The quantities which might be involved could be a real challenge to the industry.

Production May Double in Next Ten Years

The boron industry has made very substantial progress during the first hundred years of its existence here in the United States. It took nearly this period of time to reach an annual production rate of a million tons, although production more than doubled within the past ten years. It is expected that with the increased population, improvement in standards of living throughout the world and the great emphasis on boron research as well as possible fuel demands, total production will again double within ten years or less. It is the writer's firm conviction that this pioneer American industry will have a great and profitable future in the years that lie ahead.

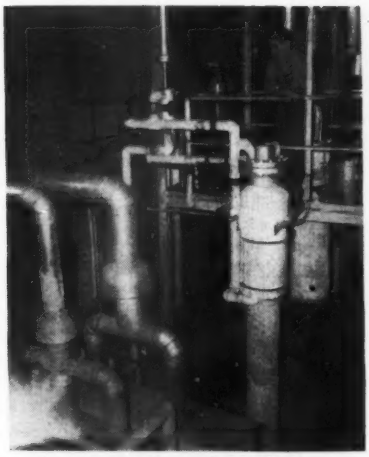


Completion in 1956 of a $20,000,000 plant gave U. S. Borax & Chemical Corp. an additional 30 percent refining capacity, but already the company is having to consider expansion of certain facilities

First installation of the BCR Easy-Flow Bin, a trouble-free bulk solid storage and handling device developed by Bituminous Coal Research, Inc. Installed at Stonega Coke & Coal Company's coke oven plant at Pine Branch Colliery, the unit handles ¼-in. by 0 coal with added filter cake

Coal Research

By J. W. IGOE
Secretary and Treasurer and Director of Administration
and
H. J. ROSE
Vice President and Consultant
Bituminous Coal Research, Inc.



Portion of the coal gasification—methanation process pilot plant at the Institute of Gas Technology for the production of high Btu gas, sponsored by American Gas Association

A broad survey of U. S. coal research activities during 1958, the article describes studies on properties of coal, production and preparation, utilization as a fuel and conversion to another form prior to end use

BITUMINOUS Coal Research, Inc., the national research association for bituminous coal, surveyed all coal research activities known to it, to discover as completely as possible the nature of coal research activities during 1958. Some organizations conducting research projects on coal or its utilization did not make information available for business reasons. This article summarizes the projects reported for the United States.

New Coal Laboratories

During 1958, three coal companies announced the construction of new laboratory facilities for testing their respective coals. Consolidation Coal Co. opened a coal and coke testing laboratory at Library, Pa. The laboratory provides facilities for a constant check on coking qualities of the company's coals and is available to the metallurgical industry for use in testing coals in which they are interested.

Island Creek Coal Co. began building a coal carbonization research laboratory adjoining its recently-expanded quality control laboratory at Holden, W. Va. The laboratory will be equipped with a full commercial-width movable-wall coke oven which will provide coke samples of normal sizes for physical and chemical tests, in addition to general auxiliary equipment.

Pittston Co. has built a coal research and testing laboratory at Carbo, Va., near the Moss No. 3 mine of its Clinchfield Coal Division. In addition to the latest equipment for testing and quality control of coal production, Pittston also will have a movable-wall coke-oven unit capable of producing commercial-size coke for testing.

The coal industry instituted a fund raising program during 1958 leading to the establishment of a coal industry consolidated research center to house the General Research Program activities of Bituminous Coal Research, Inc., now being carried out in the Pittsburgh and Columbus laboratories. A 30-acre site has been purchased for this center in Monroeville, a suburb east of Pittsburgh, Pa. It is hoped that the fund drive will be completed early in 1959.

Coal Properties

Alabama State Mine Experiment Station. In a continuing project, Alabama State Mine Experiment Station carried out proximate analyses, free swelling indexes, friability and grindability studies on coal from minor beds and minor districts in the state. It also continued the assembly of analyses and other data on Alabama coals from a literature study. Similar to its work during 1949-1955

No strangers to the mining industry, Harold J. Rose and John W. Igoe have collaborated to bring the story of bituminous coal research up-to-date.

Prior to assuming his present position with Bituminous Coal Research, Inc., Dr. Rose was vice president in charge of research, Anthracite Industries, Inc., and

H. J. Rose

J. W. Igoe

before that, assistant director of research for Koppers Co. A veteran of more than 40 years in coal and coke research, he is the author of more than 90 technical papers and 28 U. S. and foreign patents relating to coal and coal utilization. He was recently awarded the 1958 Worcester Reed Warner Medal for outstanding contributions to engineering literature.

Igoe's professional career includes broad experience in industrial writing and market development. Previously in charge of publications and technical information for BCR, he is now secretary and treasurer and director of administration of this national research agency of the bituminous coal industry.

on nitric acid oxidation rates, the Experiment Station is planning an investigation on the rate of oxidation of some Alabama coals using potassium permanganate or potassium bichromate.

Babcock & Wilcox Co. This company has been investigating the nature of chlorine and alkalies in coal, subjects which are receiving intense and increasing attention. B & W is relating routine analyses and classification of coals, lignites, etc., according to their burning characteristics and fouling tendencies, and is studying methods to alter the caking characteristics of coals. B & W is also working with the American Society for Testing Materials on the development of better analytical methods for ash fusion, chlorine and sulfur in coal. Cooperation with ASTM involves many groups; where such cooperation has been indicated in BCR survey answers, it has been shown in this article.

Illinois State Geological Survey. In addition to routine programs such as sampling and analysis of coal, and certain projects only recently initiated, the State Geological Survey has a number of fundamental research projects underway. This includes work to extend knowledge of oxygen-containing structures in coal by a study of weakly acidic chemical properties of several coals of different ranks. A report on this work is being prepared for publication. In Illinois State Geological Survey Report of Investigations No. 207, published during the past year, is a literature review on the oxidation of coal with emphasis on work published since 1945.

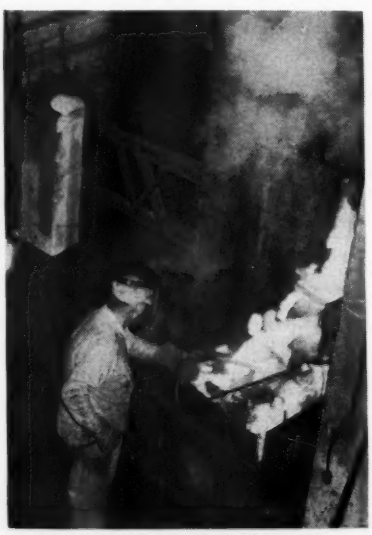
In order to learn whether more fundamental information may permit the development of better methods for determining plastic properties of coal and better interpretation of the results of plasticity investigations, the Illinois State Geological Survey has been conducting a research project on the plastic properties of coal. The first phase of this project has been completed and a report prepared for ultimate publication. This organization has continued its active participation in standardization of methods for the analysis and testing of coal and coke on national and international bases. On the national basis, ASTM Committee D-5 has advanced to standard status, methods for determination of carbon, hydrogen, nitrogen, and oxygen, and a tentative revision of the Standard Method of Test for Cubic Foot Weight of Crushed Bituminous Coal was adopted. Work on other standards has progressed.

In the field of paleobotany, the Illinois State Geological Survey has continued its long-range study of spores in coal beds and is applying the results of these studies to the identification of coal seams of uncertain correlation. Additional studies have been made on coal-forming plants revealed by the paleobotany investigations. An extensive investigation of constituents in coal's mineral matter, which may contribute to fouling and corrosion in some high-temperature boiler installations, has been initiated. Data are being assembled on other constituents, but the emphasis to date is primarily on chlorine, sodium and potassium content.

Although a study of the effect of the petrographic composition on the breaking characteristics and possible concentration of macerals in specific sizes of Illinois coals will not be completed until next year, the Survey reports that information collected thus far indicated that macerals tend to concentrate differentially in various sizes and reports also that a maceral may concentrate more in one size in run-of-mine coal and in another size in prepared coal.

Although the ultimate application of the results would be in the coal mining sequence, or its planning, the subject of one Illinois State Geological Survey research project is reported in this article under "Properties." This project is a long-range program of evaluating properties of mine roof materials in Illinois. This work has included fundamental constitution of the materials, other geologic properties, strength, etc.

Ohio Geological Survey and Ohio State University. In an extensive program resulting from conference recommendations by the Ohio Geological Survey and Ohio State University Engineering Experiment Station, the University's Solid and Synthetic Fuels Research Division began a study of fundamental properties of the Lower Kittanning coal bed in Ohio. Working with the Ohio Division of Geological Survey, an investigation of representative coal samples is in progress that will permit estimating the probable character of the coal bed between systematically planned sampling points. The study is programmed so that data not only assists present practice, but anticipates future trends in mining, preparation, and utilization of coal. The experimental work on this project is too extensive to detail in this article, but is expected to be reported by the Engineering Experiment Station as it deems appropriate.



Discharge of coke from Illinois Geological Survey movable wall pilot oven

Ohio State University, by investigating various American and foreign methods, is attempting to find the best existing method for determining total sulfur in coal and oil shale, or develop a new or modified method of achieving this objective. In a parallel investigation, this group is studying the forms in which sulfur occurs in coal. It also is carrying out a comparative study of various methods for determining chlorine in solid fuels. Other studies of coal properties include the determination of equilibrium moisture of coal for classification by rank to discover the effect of variables in the procedure of determining equilibrium moisture, ascertaining the best existing method or develop a new or modified method for determination of carbon dioxide in solid fuels, and the determination of germanium in solid fuels and their derivatives. The investigation of methods and study of analysis procedures are being conducted in close cooperation with ASTM in the light of documents made available by the International Organization for Standardization.

Complementing the chemical properties of the Lower Kittanning coal being carried out by the Engineering Experiment Station of the Ohio State University, the Ohio Geological Survey is conducting petrographic examinations of both columns and crushed coal samples of the Lower Kittanning (No. 5) coal bed from various mining operations throughout the state. This project includes a detailed study of various size fractions and specific gravity fractions to determine the petrographic variation when the coal is subjected to preparation techniques. During 1958 the Ohio Geological Survey completed its study of the small spore assemblages of the Homewood and Tionesta coal beds from northeastern Ohio and completed a chemical, mineralogic, and petrologic study of the high wall strata of a Meigs Creek strip mine in Noble County, Ohio.

Pennsylvania State University. Penn State has carried out a number of research projects relating to anthracite. During the present century, the role of anthracite as a metallurgical fuel has fallen to that of a minor blending component in the production of metallurgical coke. This

has been because of the inherent instability of raw anthracite to thermal and mechanical shock and to improvements in furnace design which have given increased heating rates. Penn State is attempting to establish the most significant variables involved and the manner in which they are quantitatively related to each other during thermal decrepitation of anthracite (i. e., the breaking up of pieces during heating). The university is assuming that decrepitation occurs when the rate of volatile matter release develops pressures exceeding the physical strength of the anthracite, and reports that this concept may prove to be of considerable practical importance. Experiments are being conducted to test the validity of the hypothesis. Another Penn State investigation involves a study of the chemical nature, physical structure, and distribution of ash in anthracite. Of particular interest in this project is the combined effect of halogen treatment and activation on the rate of removing mineral matter from anthracite. Also under investigation is a study of the relation between the grindability of coals and other properties of the coal related to its physical and chemical structure.

As a potential basis for prescribing efficient preparation, marketing, and utilization practices, a Penn State project has as its objective the amassing of data on the petrographic composition of minable bituminous coals of Pennsylvania. The university reports that as soon as possible recommendations will be made on each minable seam.

In addition to its numerous research projects dealing with anthracite and bituminous coals, Penn State is conducting a number of projects related to graphite and other forms of carbon.

Pittston Co. This company reports that petrographic and fluidity studies are being carried out in its new laboratory, in addition to the usual analytical work.

Union Carbide Corp. To assist in using coal as a chemical raw material, Union Carbide is doing research on the constitution and structure of coal. This company is also doing fundamental investigations on the nature of oxygen in coal, and reports a rapid and convenient method has been developed for determining the amount of oxygen present in vitrains. Union Carbide also contracts abroad for a general program of basic research on coal. This work is carried out at European Research Associates, in Brussels, Belgium. Some of the investigations include X-ray structural analysis of coals and quantitative functional group analyses which have been related to pure model substances similar to coal. The fundamental coal work of the U. S. Bureau of Mines is supported in part by a substantial grant-in-aid from Union Carbide which has been in effect since April 1954.

U. S. Bureau of Mines. Systematic investigation by petrographic methods of the composition of American coals was continued at the Bureau of Mines. Fundamental research on coal, carbonaceous materials, and their products was expanded. Studies of the structure of coals and coal derivatives were conducted by means of various physical methods such as X-ray, electron, neutron, and visible light scattering, electron microscopy, and other optical techniques. Samples of coal were chemically treated to permit determination of functional groups. Attempts were continued to reduce the matrix without changing the basic carbon skeleton of the coal and, subsequently, to study the chemical and physical properties of the reduced material.

In addition to these physical and chemical properties of coal, microbiological relations with coal were further investigated, including the effects of microorganisms on coal as well as on chemicals like those found in coal. The attack of coal by microorganisms has not yet been unequivocally demonstrated. Following initial experiments with humic acids and other materials, the Bureau's program has been directed toward evaluating the hypothesis that the growth of microorganisms on coal depends on the presence of small amounts of oxidized coal (humic acids) on the surface of coal particles.

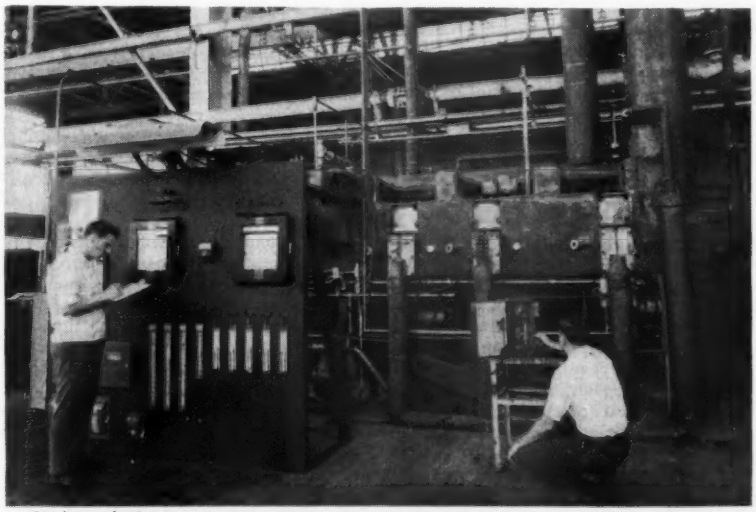
A new program to investigate the effects of radiation on the physical and chemical properties of coal was initiated at the Bureau. Small samples of coal are being irradiated. The physical and chemical properties of the irradiated coals will be analyzed using a variety of tests and then compared with data obtained by identical tests on the original unirradiated coal sample.

Investigations continued on the development of satisfactory methods for the rapid routine analysis of coal ash and related materials. Preliminary investigation of a colorimetric method for silica and a volumetric method for calcium and magnesium indicated that these methods can be applied to routine analysis of coal ash with satisfactory results for most purposes.

A method for determining sulfur retained in coal ash by rapid extraction with hydrochloric acid and by sodium carbonate fusion was evaluated and presented to Subcommittee XXI, Committee D-5, ASTM, for consideration as a standard.

For the past several years, the U. S. Bureau of Mines and a number of European coal laboratories have cooperated in developing international systems of coal analysis and classification. The proposed ISO method for the direct determination of mineral matter in coal and the Audibert-Arnu dilatometer test for determining coking properties were evaluated. Study of the proposed ISO method for mineral matter determination showed that this method, if slightly modified, is satisfactory for all ranks of American coals. A report was published on the "International Systems of Hard Coal Classification and Their Application to American Coals," incorporating the Bureau's findings on the Audibert-Arnu test.

West Virginia Geological & Economic Survey. A fundamental study of a high-germanium Bakerstown coal sample is in progress by the West Virginia Geological and Economic Survey to discover whether any correlation exists between petrographic components and germanium content.



Studying high-temperature corrosion in pilot furnace. Other corrosion studies by Babcock & Wilcox Co. cover thermodynamics of corrosion phenomena, corrosiveness of alkalis and the effect of additives on high-temperature corrosion

Other projects related to coal properties, but whose emphasis is on the application of the new knowledge, are described in the appropriate sections of this article.

Production and Preparation

Reserves. Several organizations initiated or continued investigations during 1958 on coal and associated strata with the objective of extending information about U. S. coal reserves. Some related projects, whose objectives were primarily on coal properties, were covered in the preceding section of this article.

Alabama State Mine Experiment Station has continued its collection of mine maps and coal field data to contribute to knowledge of coal reserves in that state.

Illinois State Geological Survey published Circular 260, *Strippable Coal Reserves of Illinois—Part II*, as part of its continuing project to map strippable coal reserves of Illinois in various overburden, thickness, and reliability categories. This group has prepared for publication during 1959 a report on coal resources of Coles, Cumberland, and Douglas Counties. Six additional counties are under study. Reports have been published as a part of continuing investigations of strata contiguous with the No. 6 coal in various parts of Illinois. In addition, many thousands of feet of diamond drill core, collected by principal coal companies in the state, have been examined and sampled in a study of strata associated with Illinois commercial coal beds.

Norfolk & Western Railway Co. reports continuation of its work to develop an accurate picture of coal reserves in the areas served by the N & W.

Ohio Geological Survey reports completion of the geologic mapping of coal beds and associated strata in Athens and Morgan Counties and the continuation of similar work in Stark and Monroe Counties. The Survey reports also that the original coal reserve appraisal of Ohio's coal beds, started in 1951, was completed in 1958, and a final summary study is scheduled for publication in early 1959.

Pennsylvania State University is conducting a two-phase project having as its major objective an understanding of the energy sources available in the state in terms of supply and cost. It will review energy sources currently utilized in Pennsylvania and an evaluation of energy sources not currently used but which may have future promise. Other projects reported by Pennsylvania State include an analysis of joint patterns in Pennsylvania coals and related shales to establish characteristics of the joints and any correlation with over-all geology, coal seam correlation by spore content, a geographic analysis of the coal industry of Pennsylvania and associated economic factors, and a proposed two-volume Coal Atlas of Pennsylvania—one volume to cover bituminous and the other to cover anthracite.

Acme Machinery Co., working with the Pittston Co., developed a self-propelled high lift platform for bolting the roof for use in the thick seams of Pittston's Moss No. 3 mine

The Tennessee Valley Authority, in order to provide comparative appraisals of coal resources to assist in planning coal supplies for existing plants and set proper locations for future plants, is studying the location, extent, and minability of coal reserves within TVA's coal supply area. Work in 1958 was done primarily in Tennessee and western Kentucky.

Virginia Polytechnic Institute reviewed the character of coal in Montgomery County, Va., the probable reserve, and the factors that will affect its recovery.

West Virginia Geological and Economic Survey is investigating the distribution, thickness, and stratigraphy of coals and associated strata through drill core examination of samples from central West Virginia. In conjunction with a geologic study of the West Virginia Turnpike, data are being accumulated on coal and associated rocks in southern West Virginia.

Production. Alabama Power Co. continued its sponsorship at Southern Research Institute on the development of a portable wheel-mounted dust counter for use in coal mines. That Institute reports a compact hand-carried type was developed.

The Mining Development Committee of Bituminous Coal Research, Inc., has studied a number of projects under broad classifications of mining machines, face transportation, roof support, ventilation, main line haulage, services and supply, and the application of new concepts to the mining operation. These are too extensive to report in detail, but include laboratory testing of a new concept of mining machine, automatic controls for mining equipment, problems of automatic programming of mining machines, application of transfer-boom conveyors, and the development of extensible panel and extensible room conveyors. Design studies and market studies are being made regarding recoverable roof supports recently developed, and work is continuing on infusion of mine roofs.

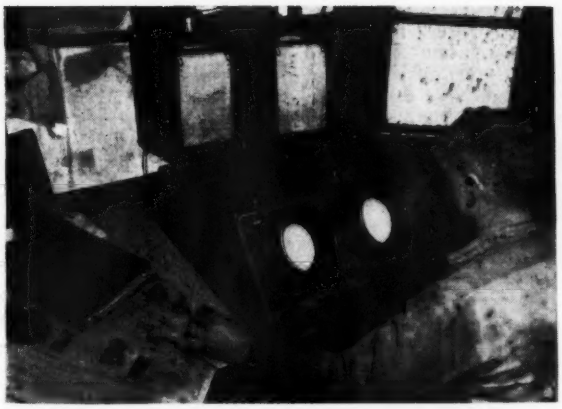
Ventilation subjects under study by the Mining Development Committee of BCR include sealings of stoppings, dust control, methane detection, and the use of plastics for line brattice. Work is continuing on the application of trolley conveyors to main line haulage. This group is also investigating the possibility of using foam as a substitute for rock dust.

Consolidation Coal Co. research continued on projects concerned with the development of new underground equipment such as shuttle cars, special new belt arrangements, and continuous mining machines. Strip mining research dealt with new explosives, off-highway haulage equipment, etc.

In a project whose ultimate purpose is increased production by continuous mining machines without decreasing safety, Eastern Gas and Fuel Associates, Inc., is collaborating with Jeffrey Manufacturing Co. on the development of a remote control system for a Colmol. Substantial progress toward this objective has been obtained, according to Eastern Gas and Fuel.

The Illinois State Geological Survey reports the initiation of an economic study of the effect of inventory changes on the stability of the coal industry. As an aid to the coal industry in the reduction or elimination of stream pollution, the University of Kentucky is carrying out a continuing investigation of water pollution by industry. Mellon Institute, in its mine water control project, under the sponsorship of the Coal Industry Advisory Committee of Ohio River Valley Water Sanitation Commission, is conducting research on methods for the control of waterborne industrial trade wastes. This work also embraces the reclamation of mined-over areas. The Ohio Geological Survey, in cooperation with the Engineering Experiment Station of Ohio State University, is also active in the field of acid mine water control.

Pennsylvania State University, in



Remote control equipment for continuous mining machines has been developed by Union Carbide Corp. Major component is a detection and guidance system which makes it possible to maintain the position of the machine in the coal seam

research on rock mechanics, is attempting to more adequately describe physical factors which influence behavior of the roof and floor in coal mines, and is also attempting to evaluate shock losses at splits and junctions in mine airways as part of its ventilation research.

Pittston Co. reports the development of a new roof bolting machine in cooperation with Joy Manufacturing Co. This machine is an innovation in that the platform can be tilted in any direction to follow the contour of the mine roof and still provide level footing for the operators.

Union Carbide Corp. reports that its remote control equipment for mechanical mining, developed over a several-year period, has been made available to the coal industry through lease to Joy. The general concept of this equipment has been described in other issues of this magazine; the major component is a detection and guidance system which makes it possible to maintain the position of the mining machine in the coal seam. Union Carbide is also investigating methods of low-cost mining and movement of coal to processing units.

Virginia Polytechnic Institute is attempting to establish those factors which affect the strength of coal mine pillars and to correlate these factors with the strength of pillars in mines. They are also attempting to correlate data pertaining to bumps which have occurred in mines with the cause of bumps.

The U. S. Bureau of Mines initiated a new program to explore the potentials that can be realized by hydraulic mining. Plans were prepared, equipment obtained, and a mining site is being readied. Tests are scheduled to begin in the coming year.

Comparative studies were completed in 14 mines in West Virginia and western Pennsylvania on the effect of conventional timbering and roof bolting on coal production. To provide a basis for choosing optimum combination of mining systems and equipment, a series of comparative studies was completed in 13 mines.

A third comparative study concerned two operating units, one using piggyback and the other chain conveyor face haulage. Results obtained indicated that production from the section equipped with chain conveyors was higher for the conditions studied.

Virginia Polytechnic Institute is studying the mineral composition of coal mine floors and the effect of such composition upon load-bearing properties of the floor.

Under sponsorship of Christopher Coal Co., the West Virginia University Engineering Experiment Station is investigating the emission of combustible gases from the Pittsburgh coal bed and the possibility of degasifying the coal in advance of mining. Other research projects by the Experiment Station cover devices and methods for suspension roof support, an analysis of stresses and movements in mine roof strata and in coal pillars during mining, a study of sulfur balls in coal beds related to the operation of continuous mining machines and other mining equipment, and the relative corrosion rates of acid mine waters working on various steel alloys and protective coatings.

Preparation. In order to develop new or improve current preparation practices, several companies and organizations reported preparation research underway.

Babcock & Wilcox Co. has been engaged in development of the equipment to cleanse coal of pyritic sulfur at power plants and has conducted determinations of washability characteristics of selected coals. Bituminous Coal Research, Inc., under its General Research Program, is continuing its development work on a dry electrostatic process to clean fine sizes of coal. The objective is the development of a cleaning process with fewer problems and lower capital investment. BCR has arrived at the field testing stage in the development of a method to continuously determine coal moisture. The first field test involves a full-scale installation in a preparation plant. The Mining Development Committee program of BCR is investigating cleaning and drying of fine sizes of coal by other methods in parallel investigations.

The Ohio State University Engineering Experiment Station and the Division of Geological Survey has collaborated in a joint publication on the washability characteristics and other properties of Meigs Creek No. 9 coal bed in Ohio.

The development of new techniques of separating solid fractions from coal slurries on a laboratory scale is underway at Pennsylvania State University. The Pittston Co., at its new research laboratory, is maintaining a quantity control section which is developing float and sink data. The University of Kentucky is investigating the cleaning of fine sizes of anthracite in a separatory cyclone using a suspension of magnetite.

Coal preparation studies at the U. S. Bureau of Mines are concerned with a variety of techniques, including dense-medium separators, flotation units, jigs, and cyclones.

In its investigations and attempts to improve dense-medium processes for cleaning coal, the Bureau is conducting a fundamental study of the factors influencing the movement of particles in suspensions. Terminal velocities were measured of coal particles falling through zinc chloride-sucrose solutions of various viscosities but possessing zero yield value. Observations using magnetite suspensions having equivalent viscosities and significant yield values indicated that terminal velocities were retarded greatly for particles smaller than ½-in. size.

Tests to determine the effect of pulp density on flotation rates again indicated the striking difference between kerosene and froth flotation: in froth flotation, the behavior of one particle does not depend greatly on the presence of other particles, whereas in kerosene flotation it does.

Tests with a ¼-in. by 0 feed to evaluate the washing efficiency of a feldspar jig indicated that when cleaning an unsized feed the unit offers little promise of effective cleaning in the minus 48-mesh size range. With unsized feed the jig would, therefore, appear to be useful only when the proportion of material finer than 48-mesh is small or when the material of this size is naturally clean.

The Dutch State Mines has introduced a new type of screen, the "sieve bend." Reports on its performance indicate that its capacity is significantly greater than that of a vibrating screen, that it can operate below the size range in which conventional screens are effective, and that it is relatively free from blinding. The Bureau of Mines tested a small sieve bend at its Seattle, Wash., station. The effects of feed rate, size, and slurry concentration were investigated. The tests demonstrated that

the sieve bend can size effectively down to ¼mm. (1/100-in.), has an exceptionally high capacity (approximately double that recommended by the manufacturers), but is inferior to vibrators as a dewatering device.

A series of tests was conducted with an impact-type pulverizer to determine the effect of moisture in lignite on pulverizer power consumption. The power requirements decreased with decreasing moisture content despite a slight increase in the percentage of minus 200-mesh size produced at the lower moisture figure.

A survey was made of freezeproofing lignite by adding spray oils with and without commercial chemical additives. Although the agglomerating strength of all oil-treated lignite samples was significantly lower than that of untreated samples, the additives had no significant effect. Spray oils used in general practice appeared to be most efficient.

The survey of preparation characteristics of American coking coals was continued, and two reports (on Wise and Dickenson Counties, Va.) were published in 1958. To date, 35 preparation reports have been published, incorporating data on counties in Pennsylvania, Kentucky, Tennessee, Virginia, and West Virginia.

Virginia Polytechnic Institute, during 1958, studied the washability of semi-anthracite in Montgomery County, Va., and the Engineering Experiment Station of West Virginia University carried out studies on the cleanability of West Virginia coals. The Experiment Station conducted research on the prediction of power requirements for crushing coal and its associated impurities.

Utilization as a Fuel

Research described in this article under the broad term "Utilization As A Fuel" will cover fields related to the actual burning of coal such as in-plant and pipeline transport, storage and economic studies.

Babcock & Wilcox Co. research falls into five groups: (a) the development of coal-burning equipment, (b) slag and ash deposit investigations, (c) improvement of boiler cleaning techniques, (d) air pollution control, and (e) control of coal-ash corrosion. The coal-burning equipment development includes work on burners for utilizing low-volatile, high-ash coal; pulverizers with increased capacity and lower power requirements, development of chain grate stokers to burn a wider range of coals at greater rates; burning coal in a stationary bed with liquid ash removal; air heater development and an investigation of factors important in burning char. B & W has been working on the development of sensing elements for automatic soot blowing systems, and on techniques of cleaning air heaters for various operating conditions, and vibrating cleaning of heat absorption surfaces. The air pollution work by B & W involves investigation of methods for controlling sulfur, nitric-oxide and other gases, and on fly ash reinjection to cyclone-furnace boilers. Corrosion studies cover thermodynamics of corrosion phenomena, high-temperature corrosion in a pilot-scale furnace, corrosiveness of alkalis, and the effect of additives on high-temperature corrosion.

Approximately half of the coal industry's cooperative research program, carried out under the General Research Program of Bituminous Coal Research, Inc., concerns itself with utilization of coal as a fuel. Bituminous Coal Research, Inc., continued its equipment development work which has a long-term objective of providing competitive package-type automatic steam generating plants for commercial and small industrial installations. Two units, the Fire-Jet manufactured by the General Machine Co. and the BCR-IBW Coal-Pak, were field tested during 1958 and are being sold commercially. The field units demonstrated the technical and market potential of both units. Current work in this field by BCR is toward simplifying operation and reduction of manufacturing costs. Penn State University conducted combustion tests with the Fire-Jet using Pennsylvania coals.

Working with its standard reference steam coals, BCR has conducted a three-phase approach to understanding the factors affecting plasticity of bituminous coals in relation to their performance on stoker grates and to the design of combustion equipment. Bench-scale, pilot-scale, and full-scale research have been carried out. Results to date indicate that it will be possible to provide a means for predetermining the performance of a given coal on the basis of bench-scale tests. This work has been a cooperative effort with the work on Pennsylvania coals being sponsored by the Pennsylvania Coal Research Board and the work on non-Pennsylvania coals by the coal industry.

During 1958 the Association of Edison Illuminating Companies and the Edison Electric Institute joined with the coal industry to jointly sponsor, at BCR, a two-project research program whose objective is the control of sulfur oxides from power plants. A project on the control of atmospheric contaminants in flue gases includes an investigation of methods currently available, bench-scale studies of promising new methods, and cooperation with other organizations active in this field. The other project, concerned with sulfur reduction in steam coals, has as its objective the development of fundamental information on the nature and occurrence of sulfur in bituminous coals and the development of new approaches to the problem of sulfur removal.

A major breakthrough of Bituminous Coal Research, Inc., in the field of improving the flow of bulk solids from storage was tested in a full-scale silo at BCR's Columbus laboratory during 1958. Silo tests substantiated previous pilot-scale tests and Fairmont Machinery Co. began commercializing the unit. A number of commercial installations at coal preparation and utilization plants have been made or are under construction. BCR is currently working on the development of construction materials for bins and in extending the application of this device, and is sponsoring fundamental research studies at Ohio State University on the flow of bulk solids in bins. The organization is also investigating a pneumatic system to provide in-plant coal transport at reduced cost.

BCR continued its research on utilizing fly ash from pulverized-coal-burning installations. This work included tests of water permeability and absorption characteristics of fly ash concrete mixes. Applications in the field showed cost reduction in mine shaft construction as a result of this work.

The Locomotive Development Committee of BCR continued standing bed tests of its coal-fired gas turbine for locomotive and general power plant use.

Consolidation Coal Co. reports that its Georgetown pipeline, for transporting coal suspended in water, was operated in 1958 at excess of design capacity by a significant margin and reports that all parts of this line were brought to successful completion during 1958. The company also reports research in desulfurizing coal and char.

Eastern Gas and Fuel Associates is carrying out a large-scale investigation and test program on the efficiency of mixing coals and their flow through commercial storage bins.

In the field of economic research on coal utilization the Illinois State Geological Survey during 1958 published IGS Circular 259 entitled, *Fuels and Power in Manufacturing Industries*, which covered the years 1947 and 1954. Mellon Institute continued its air pollution control studies under the Industrial Hygiene Foundation of America and the Air Pollution Control Association.

North American Coal Corp. has undertaken preliminary studies on special fuel products from coal.

In addition to its stoker research mentioned earlier, Pennsylvania State University is correlating laboratory tests on ignitibility and reactivity of Pennsylvania bituminous coals with their combustion performance. The university is also investigating the thermal ignition characteristics and burning rates of finely divided solid fuels. Pure substances, such as graphite and organic compounds of known

structure, are being studied as an aid to understanding the combustion processes involved. To arrive at a better understanding of the kinetics of hydrocarbon combustion and other high temperature reactions, Penn State is using shock waves to heat gases for study at high controllable temperatures.

The Tennessee Valley Authority air pollution studies include dispersion of smoke from power plant stacks, effects of sulfur dioxide on vegetation, and the formation of sulfur compounds in coal combustion; these subjects are being investigated to determine the extent to which air pollution control measures may be justified at power plants. TVA has conducted tests of the properties of concrete in which part of the normal cement content is replaced with mechanically-collected fly ash. Optimum values for fractional replacement have been determined and strength tests are being made on cores from field-poured structures. TVA's objective is to prove the advantages of fly ash for use as a commercial fractional replacement for cement in concrete.

The research work of Union Carbide Corp. is principally directed toward coal as a chemical raw material, but the company reports that since heat requirements are important in chemical processing, specialized uses of coal as a fuel are also being investigated.

United Engineers and Constructors, Inc., in describing its research on desulfurization of high-sulfur caking coal in a fluid bed, has reported some success and further work on this project under its current sponsorship by a public utility is anticipated.

Preliminary tests were made at the U. S. Bureau of Mines on a pilot-scale apparatus for studying pulverized-coal flames. Tests were directed towards determining conditions necessary for a well-defined flame with good combustion of the coal.

In continuing studies of methods for alleviating corrosion of boiler tubes, attention has been directed to the presence of sulfur in ash and slag deposits. Elemental migration was observed in these deposits.

In conjunction with the testing and consulting services available to Federal heating plants on boiler-water problems, the Bureau's industrial water laboratory conducts research on the causes and prevention of water-side boiler corrosion and deposits, and on stream pollution. Current studies are centered on the evaluation of filming amines under varying conditions of use.

Virginia Polytechnic Institute is investigating the possibility of using a coal-diesel oil mixture as a fuel for diesel engines.

Ohio State University studies of coal properties include determination of equilibrium moisture of coal for classification by rank to discover the effect of variables in the procedure of determining equilibrium moisture

Conversion

Research on various aspects of converting coal prior to its end use receives major consideration by companies and institutions conducting research in the United States. Where the specific approach is known to the authors of this article, the research projects have been classified according to broad subject classifications. The others, including some of a fundamental nature with potentially broad application, are grouped together in this paragraph. Consolidation Coal Co. continued its research during 1958 in the general field of up-grading coal toward the production of gases, liquid fuels, and chemicals. On December 30, 1958, Consol announced jointly with Standard Oil Co. of Ohio a joint basic research project to explore methods of manufacturing hydrocarbon liquid fuels from coal. The two companies' jointly-owned affiliate, the Mountaineer Carbon Co., Cresap, W. Va., has been engaged in the calcining of coke for the aluminum industry. Consol has been engaged in research in the field of the newly announced joint research venture and Standard Oil of Ohio will begin active participation during 1959 at its Research Center and its Process and Product Development Division Laboratory in Cleveland. The two companies indicate a five- to ten-year period of research and development prior to consideration of commercial possibilities. Union Carbide conducts a broad program of research on coal as a chemical raw material.

Carbonization. A substantial number of companies, universities, and governmental research groups were engaged in carbonization research during the past year. Alabama Power Co. continued its low-temperature carbonization work that has been underway for a number of years. Battelle Memorial Institute explored low-temperature tar from Texas lignite; made engineering appraisals on low-temperature carbonization processes, and carried out a program of evaluating coking coals.

A major objective of the research of Eastern Gas & Fuel Associates has been the continued development of the art of carbonizing coal for more efficient production of coke, gas and coal chemicals. The company's activities in general have been of an engineering and development nature. In line with its objective, Eastern Gas & Fuel conducted movable wall oven tests and expansion tests for improved utilization of various coals in producing domestic and metallurgical coke; conducted pilot-scale carbonization tests in an electrically-heated oven, and studied the effect of carbonization variables on the quality of coke; used a sole-heated oven to determine expansion and contraction characteristics of various coals. The company reports the successful development of a process for using blast furnace flue dust by carbonizing with coking coal. Laboratory research was confirmed by plant-scale tests, and the company has completed a full year's commercial production and use of "ferro coke." It reports that production and use have been accomplished without damage to ovens or blast furnace. Physical and chemical coke testing procedures have been investigated and coke reactivity has been given considerable study. Eastern Gas substantially increased its research facilities during 1958 and plan an expansion of activities similar to those engaged in during 1958.

Illinois State Geological Survey, in order to meet the need for small reactive coke suitable for ore reduction in electro-metallurgical furnaces, conducted research toward that end and demonstrated that Illinois coal may be carbonized by itself to produce a product for this purpose. The Survey reports that the coke is highly fractured and brittle and crushes easily into a suitable size range without excessive fines. Its study of Illinois coals for foundry coke and for blends with petroleum coke in the production of blast furnace fuel shows promise. Other research by Illinois State Geological Survey involves pilot-plant

coking tests on blends of coal and fusion and laboratory-scale coking studies of Illinois coal with high-carbon components. Weathering tests followed by coking in a pilot coke oven indicate that Illinois coal may be stockpiled successfully over the summer months provided it is to be subsequently blended with medium-volatile or with medium- and high-volatile Eastern coals. The Survey has paralleled its technical research with an economic study of the position of Illinois coal for use in the manufacture of metallurgical coke.

In a project sponsored by U. S. Steel Corp., Mellon Institute has conducted basic investigations of the chemicals produced during the coking of coal, the physical and chemical properties of coal chemicals, and their conversion into new and more useful substances.

Research sponsored by private interests and through the Natural Resources Research Institute of the University of Wyoming has been in progress at the Institute on the production of synthetic coke from subbituminous coals. The objective has been the production of a coke with good physical properties and satisfactory reactivity as a reducing agent. With its own funds, NRRI has conducted research on the properties of chars from Wyoming coals and on the activation of subbituminous coals. It has continued, with the support of several coal and power companies, an investigation of primary tars and oils from low-temperature carbonization of lignite and subbituminous coals.

North American Coal Corp. has been active in preliminary studies on coal carbonization. Ohio State University has conducted studies on low- and high-temperature carbonization of both coal and oil shale, as well as on composition of the coal and oil shale carbonization gases. The university has also carried out work to develop better methods of separation and analysis of gaseous hydrocarbons.

As a result of a study of basic chemical constituents of bituminous coal through the use of a mass spectrometer to analyze the primary degradation products of coals when they are heated to elevated temperatures, Pennsylvania State University expects to determine whether the heavy molecular constituents of coal break down during the gasification process itself, or whether these products are only decomposed by secondary collision with a hot surface or with each other.

Penn State is also carrying out research on the following carbonization projects: effect of radiation on the physical and chemical properties of bituminous coal and coal by-products; the production of metallurgical coke from blends of anthracite and bituminous coals, and the effects of chemicals on the yields and nature of tars produced by low-temperature carbonization.

Pittston Co. is starting an investigation of European test methods of evaluating coking properties in comparison with American methods. Studies are in progress on oxidation as it affects coking properties, and also burning and storage qualities.

Following former programs on low-temperature carbonization of coal, Southern Research Institute, during 1958, conducted economic studies and encouraging outside activity on tar utilization.

Union Carbide Corp. is conducting an investigation of the primary liquid products from coal hydrogenation and carbonization processes to determine their properties and uses. The company is also a co-sponsor of an extensive investigation of the properties and utilization of lignite tar.

United Engineers and Constructors reports that it has developed a completely instrumented prototype operation for low-temperature carbonization of coal. The company indicates it is ready for commercial exploitation when economics are favorable.

In continuing studies of the mechanism of coking, blends of a coking coal and small, closely sized coke were carbonized, and the strength of the resulting coke was determined at the U. S. Bureau of Mines. The strength of the carbonized blend decreased as the size of the added inert (coke fines) was increased.

Supplemental and related investigations by the Bureau were made of the effects of such variables as preheating of coal, bulk density, flue temperature, and pressure developed during coking.

In cooperation with Western steel producers, a series of coke-improvement studies on Western coking coals and coke-plant blends was conducted.

Carbonizing properties were determined for coals from Pennsylvania and West Virginia on a county basis in a continuation of the study of the coking properties of potential coking coal reserves.

Research by the Bureau on low-temperature tar included separation and characterization of tar components and upgrading and utilization studies of tars. Work was continued on chromatographic and solvent separation of tar fractions, on infrared and spectrometric identification of compounds and homologs, and on chemical conversion to more useful substances. An interesting discovery was the fact that structures identified in the acid fraction were found to occur in the basic and neutral fractions as well.

To obtain fundamental data for use in developing a practical conversion process for high-boiling tar acids, a kinetic study of dealkylation of alkyl phenols was initiated.

The University of Utah has been conducting fundamental research to determine the mechanism of char and coke formation during carbonization of high-volatile bituminous coal. Techniques being used include infrared determination of chemical bond changes during carbonization and mass spectrometric and chromatographic determination of gas phase composition changes.

The West Virginia University Engineering Experiment Station, under a Weirton Steel Co. Fellowship, is making dielectric determination of the coking qualities of coals.

Gasification. Alabama Power Co. continued its underground gasification work. The American Gas Association reports a development project in the pilot plant stage on a process to produce 1000 Btu synthetic gas from coal. North American Coal Corp. has begun preliminary studies on gasification of bituminous coal.

Penn State is making several gasification studies using high-purity carbon as the base of their studies. United Engineers and Constructors have achieved promising results in the gasification of coal by rapid high-temperature carbonization in dispersed phase.

Construction of a slagging gasifier to study the gasification of lignite with oxygen in a fixed-bed has been almost completed at the U. S. Bureau of Mines.

In a cooperative program with the Atomic Energy Commission, the Bureau continued testing and departmental work on the use of nuclear heat for coal gasification. An induction-heated simulated nuclear reactor and heat-transfer loop were designed and operated with helium as the heat transfer medium at atmospheric pressure. This system was then redesigned for preliminary testing at pressures up to 250 lb. Testing of materials for the various heat transfer components continued.

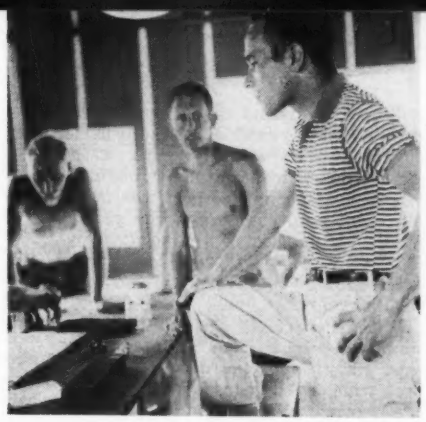
The effect of hydrogen on the steam-carbon reaction was investigated in connection with coal-gasification studies. Initial experiments showed that the reaction is strongly inhibited by low concentrations of hydrogen although higher concentrations had little further effect.

Development of techniques for feeding pulverized coal into pressure gasifiers continued at the Bureau. A slurry feeder was redesigned for convection heating, as direct radiant heating led to caking difficulties in the coils. A steam pick-up system was constructed and preliminary investigation of operability of components was begun.

Underground gasification experiments continued with hydraulic fracture techniques for seam preparation, and gasification with oxygen-enriched air was initiated.

Under a series of Bureau of Mines Fellowships, the West Virginia University Engineering Experiment Station, during 1958, conducted investiga-

(Continued on page 100)



An energetic, high caliber faculty is of prime importance in developing top quality mineral engineers. Men who can capture their student's interest in a particular field and are willing to devote much more than ordinary classroom time to their job, like this young man pictured conducting a late afternoon seminar at a summer camp, are essential to the future progress of the mineral industry

Supply, Demand, and Future Outlook for Mineral Engineers

Government and industry—the main users of scientific manpower—must help education attract top quality teachers, provide improved facilities for classroom studies, and answer the vital question, "How many engineers and scientists do we need?"

By JOHN W VANDERWILT
President
Colorado School of Mines

THE crying need for scientists and engineers has been a dominant note of the public press for the past several years. Everywhere editorials and advertisements have emphasized the need for highly trained engineers and scientists. This demand for engineers has been tempered by a warning of a different sort. Various industrial and educational leaders argued that many engineers were not utilized to the fullest of their trained ability, and that the shortage of engineers could be offset materially by more efficient use of the available supply. Recently the *Wall Street Journal* exclaimed that many of the problems in the foreseeable future would be solved by a program of better uilization of the existing working force of engineers.

Opinions have been given by responsible persons in industry to the effect that we have enough engineers to do all that must be done—and further that we are not utilizing the engineering manpower that we have. It is claimed by some that a relative few U. S. companies perform the bulk of the engineering for national defense. This, it is argued, is one of the important causes for poor utilization of the present over-all engineering working force; engineering talent to be found in the many smaller companies throughout the country is not reached.

Other statements can be found to substantiate the charge that available science and engineering manpower could be used more appropriately. It is not my task nor would space permit full development of this problem. However, the problem is important and cannot be ignored in any analysis of supply, demand, and future outlook for mineral engineers.

In the fall of 1956, some quarter of a million students were enrolled in 219 four-year American institutions offering programs in engineering education. In June 1957, from this crop, the United States harvested 31,211 new engineer graduates in all fields—included were 1718 mineral engineers. Is this crop large enough? Will the supply of new engineer graduates be enough? What will be the demand for engineers? Can they be used more productively, in better-suited occupations and positions? And most important of all, what is the future outlook for the mineral engineer?

These questions plague the industrialist and educator when he considers his world—a world now in a headlong dash toward utilization of engineering and science for peace and survival.

In order to provide a background and a basis for evaluations of the outlook for the future, let us consider first the present and future supply of engineers; second, the need or demand now and in the future for engineers; and finally, combining these two, suggestions and conclusions will be given on the future outlook for mineral engineers.

John W Vanderwilt's career as an educator began in 1923 when he first served as an instructor at University of Colorado. After completing graduate studies in economic geology at Harvard, Vanderwilt spent alternate periods engaged in geological work for the U. S. Geological Survey and teaching at University of Colorado. Following many years as a leading consultant and author, he became president of Colorado School of Mines. Presently he is also on the Board of Consultants, U. S. Bureau of Reclamation.

Present and Future Supply

In 1950 this country's educational institutions produced 52,732 new engineers. Of this number 2694 were trained specifically for the mineral industries, constituting 5.1 percent of the total new engineers that year. In 1953, because of the low birthrate in the depression-era of the 1930's, the number of new engineer graduates dipped to an alarming 24,000, less than half the figure of 1950. Of these 24,000 engineering graduates in 1953, 6.7 percent or 1600, were mineral engineers. The year 1954 saw the lowest figure of the recent years, with but 22,236 engineers graduated with their first degree. That year also saw 1417 new mineral engineers enter the field, comprising 6.3 percent of the total production for the year.

Statisticians estimate that the rate of production of mineral engineers

Table I
New Mineral Engineer Graduates

	Total Engineers	Mineral Engineers	Percentage of Total
1950	52,732	2694	5.1
1951	41,893	2420	5.8
1952	30,286	1852	6.1
1953	24,000	1600	6.7
1954	22,236	1417	6.3
1955	22,474	1326	5.9
1956	26,306	1385	5.2
1957	31,211	1718	5.5
1960 (estimate	40,000	2400	6.0

will remain around six percent of the total engineers graduating in all fields for the next several years, after which the percentage may increase slightly. Using six percent, the number of mineral engineers to be graduated will increase to around 1900 by next year, 2400 by 1963, and thereafter remain relatively constant for several years.

With these facts and statistics on supply before us, let us interject a cautionary note regarding statistical projections. All fields of engineering are dependent on a common foundation of basic sciences. Consequently, predictions as to the future in any particular engineering field is related to each of the other fields. Furthermore, the demand for trained personnel in non-engineering fields relate to the problem because they too compete for the attention and interest of high school graduates.

The pool of college-age young people in the United States is very large. A recent National Council of Education study shows 9,000,000 potential college students in the age 18 through 21 bracket. This age group will grow to nearly 10,000,000 by 1960, 12,000,000 by 1965, and over 14,000,00 by 1970.

These are staggering numbers. The potential is great and doubtless would be adequate for all needs in science, engineering, and non-technical fields if it could be developed fully. Consider, however, that only 34.6 percent of the college-age population went to college in 1957. This percentage is expected to increase somewhat in the future. Roughly eight percent of the total college enrollment is in engineering. Salaries and other incentives will influence relative competitve positions among the fields of college graduates. Therefore, at best, statistical studies and projections are limited in accuracy. Table I shows the total engineer graduates in all fields; the new mineral engineer graduates for 1950 through 1957, and the estimated figures for 1960. Table II shows the degrees and the number of colleges granting the degrees from 1950 through 1957 in the several fields of mineral engineering.

Demand for Scientists and Engineers

Having considered the supply situation let us now consider indicated demands for scientists and engineers. It is doubtful that anyone would question that the engineer and scientist will become increasingly important and essential in government and industry in the years ahead. For this reason the problems of engineering education in providing a continuing supply of these products is of vital concern to industry, society, and the nation. The problems of engineering education cannot be developed fully in this limited space, but engineering education, like more efficient use of scientists and engineers, must be given constant attention—education will provide final answers as to the future.

Kiplinger's *Changing Times* recently stated that engineering will continue as one of the fastest growing occupational fields for men. The growth will continue, Kiplinger says, but the pace may decrease slightly. The biggest need will be for the broad-based engineer with wide knowledge. Of prime concern to me is the statement that the best salary schedules will come first in the industrial fields, government second, and teaching third. As an educator, the writer feels honestly that engineering education has been and is being slighted and that, if continued, this trend will seriously affect the future outlook for the supply of well qualified mineral engineers.

It is doubtful that anyone would seriously debate the question "Can the United States use more scientists and engineers?" To do so would be to argue that we have no need for more new knowledge concerning our physical surroundings and no need for men with abilities to further utilize knowledge for man's benefit. Progress would stop. The demand for scientists and engineers rests on the solid foundation of ever increasing, (1) needs for scientific minds capable of seeking out new basic knowledge and, (2) needs for engineering abilities for converting basic knowledge to practical use.

It is not logical to evaluate such an essential demand in terms of enough or too much. Surely more science and engineering is practical—it's as simple, or perhaps we should say complex as a business man's problem of how much of his profits to funnel back into his company in order to expand or to produce a better product. The hidden meaning is the same. Will more knowledge and use of it, like the profits, be used wisely and effectively?

Useful measures for estimating future needs for science and engineering include, (1) expansion of research, (2) national industrial growth, and (3) increasing population.

A recent McGraw-Hill survey points out that, in 1941, 0.9 billion dollars was spent for basic and industrial research of all kinds. This increased to 5 billion dollars in 1953. Estimates by other agencies state that research expenditures will increase to 9 billion dollars annually by 1960. This anticipated tenfold increase in research in 20 years must be carried out in the main by scientists and engineers whose numbers are expected to increase only twofold over the same period.

Industry and the United States as a whole during the past two decades has increased the number of scientists used from 92,000 to 250,000 and the number of engineers from 286,000 to 600,000. During this period the ratio of scientists and engineers combined rose from 1 in 148, to 1 in 80 of the total labor force. Statistical surveys also give these ratios as 1 to 100 in 1920, and 1 to 60 in 1956. With the normal three to six percent growth of industry, plus the trend of increasing ratio of scientists and engineers to total labor force, the demand for science and engineering cannot help but expand.

Smaller companies throughout the country represent a potential for increased demand for scientists and engineers. A considerable number of companies up to now have been unable financially to support research programs—although this claimed inability to pay may represent lack of

Table II

Degrees Conferred—1950 to 1957[a]

Year	Geological Engineers				Geophysical[b] Engineers				Metallurgical[c] Engineers				Mining Engineers				Petroleum[d] Engineers			
	Colleges	Degrees 4-yr	M	D	Colleges	Degrees 4-yr	M	D	Colleges	Degrees 4-yr	M	D	Colleges	Degrees 4-yr	M	D	Colleges	Degrees 4-yr	M	D
1950	11	333	20	..	..	..	..	..	40	950	180	46	21	463	32	1	13	948	71	2
1951	13	308	31	3	..	..	..	..	39	797	236	40	21	469	44	2	16	846	65	2
1952	13	261	17	4	..	..	..	..	41	578	134	53	19	371	30	3	17	642	74	3
1953	15	217	33	8	..	..	..	..	40	542	123	56	19	288	19	1	15	564	31	4
1954	13	186	9	2	..	..	..	..	41	492	136	53	19	254	22	3	14	481	65	6
1955	14	182	20	..	3	25	6	1	43	449	146	62	20	204	24	2	15	467	64	5
1956	12	197	8	1	3	20	6	1	41	477	133	72	23	190	24	3	13	501	64	4
1957	11	227	19	1	3	33	2	..	44	577	134	52	21	231	22	..	16	650	87	4

Table II: distribution of degrees granted and the number of colleges in the fields of mineral engineering. Chart uses figures from only those institutions accredited by the Engineering Council for Professional Development.

a–Data supplied by the U. S. Department of Health, Education and Welfare, Department of Education

b–Data for 1950 to 1954 not available

c–Includes physical, extractive, beneficiation and other fields

d–Includes petroleum-refining engineering

confidence instead. Progressive companies and other organizations have demonstrated that sound research and engineering not only are practical and profitable, but also influence growth and survival. It is the writer's personal conviction that the use of scientists and engineers will be more general in the future than it has been up to now.

A word or two should be said about demands for advanced studies in all engineering fields. The trends in engineering education for over a decade have been; (1) toward greater emphasis on more fundamentals in the physical sciences, (2) a broader education, commonly referred to as the humanities, and (3) more graduate work. Men with completed graduate programs qualify for higher beginning salaries. In response to this incentive, graduate engineering programs have grown. Further material increases in graduate studies in science and engineering are anticipated.

Studies by or on behalf of the mineral industry concerning future needs for mineral engineers have not been made and are sorely needed. Indications are that the increases in the number of new mineral engineer graduates are relatively less than in other fields. The Paley Report in 1952 presented convincing data indicating that the demand for various minerals, metals, and fuels will increase in amounts ranging from 50 to well over 100 percent by 1970 to 1975. Subsequent actual consumption suggests that these estimates are conservative. The mineral industries in common with other industries must grow to meet the expanding needs of an increasing population. Mineral engineers will be in continuing demand for this task.

Colleges of engineering will require enlarged faculties both for undergraduate and graduate work. The need for teachers represents another important continuing demand for scientists and engineers.

The several areas of demand for scientists and engineers in industry and general business, in government and in engineering education will be competitive with each other. The several fields of science and engineering also compete with each other for the interest of the high school graduate. Engineering education holds the key to meeting the nations over-all requirements for scientists and engineers. Educational facilities, public and private, must be expanded, faculties enlarged. Superior teaching in all areas, and especially in science and engineering fields, must be provided to maintain high standards in engineering education.

Official estimates based on careful studies are that 40,000 new engineers are needed yearly for 10 years to serve the demands of industry, government, education, and national defense and to close the gap existing between supply and demand. Projections made by the U. S. Office of Education indicate that graduation of this number will not be attained until 1960 or 1963. In view of the many areas in which the use of scientists and engineers may grow and considering the many areas in which the uses are essential, this estimate of future needs may prove to be conservative. One things is certain, an adequate and continuing supply of science and engineering talent must be assured.

Future Outlook for Mineral Engineering

Finally, under these circumstances what is the future outlook for mineral engineering? My comments on this subject will be iln the nature of a summary and personal conclusion.

Careers in any field of mineral engineering offer interesting work, a good livelihood, and a worth-while way of life. It is understood that the individual's attitude and personal qualities are of prime importance. Mineral engineering is not for those who expect to receive a great deal, without giving in return, much intelligent and hard work. It is not for those who shun responsibility or are afraid of challenging assignments.

It is my studied opinion that future opportunities for the mineral engineer will continue to be execellent. However, as the number of new graduates increases from year to year, it is only natural that increasing emphasis on quality will be made by the employer; a decrease is to be expected in industrial eagerness to make job offers merely on the basis of a degree; and the student himself, faced with this situation, will have to reevaluate his attitude, study even harder and not be overly demanding. The prospect for job opportunities is best illustrated by the experience in the spring of 1958 of the graduating class in one of the departments at the institution the author represents. The seniors in this department numbered around 30 new graduates. Prior to the close of the school year one outstanding man received eight job offers but two in the class had received none. A few had turned down job offers for personal reasons and on last report were regretful of their decision. Such variations are to be expected in the future among each year's new mineral engineer graduates, and new graduates in other engineering fields as well.

As time goes on, there will be increasing emphasis on quality and a broad background in both technical knowledge and human affairs. Continued professional and personal growth will be expected. The professional engineer, to be truly successful, must develop through the years a competence and personal integrity that will command the respect and confidence of his employers and his colleagues. Many will recognize that this suggested outlook for the future is not to different from that of a quarter or half a century ago.

Without adequate tools for study and research, the best faculty cannot prepare students for the future. If the mineral industry is to remain up-to-date and on equal footing with its competitors, institutions of higher learning must have adequate facilities. Shown is the new million-dollar metallurgical engineering building at Colorado School of Mines. It affords opportunities for faculty and students alike to help advance the science of mineral engineering

Problems Facing the Employer

From the employer's point of view, whether in industry, government, or education, the outlook for maintaining truly adequate science and engineering needs will continue to be a difficult task. This problem will be no less difficult in mineral engineering than in other related fields. Statements that the supply of engineers is adequate for the general needs or work to be done without taking into account quality and competence is to say in effect that we now have enough of knowledge and of its use.

In our system of free individuals and free enterprise, adjustment and readjustment have been characteristic of the inevitable march forward and upward. Recognition of past mistakes and their correction also is characteristic. Failure on the part of some to recognize and appreciate the critical importance of science and engineering can be classed as a mistake of the past. Inefficient use of scientists and engineers falls in this category. Diverting engineers from their chosen fields to managerial positions by means of salary incentives has long been questioned as a good procedure. Recently a large company released to the press its new plan for promotion of recognition of its outstanding research scientists and engineers. A spokesman for the company stated that, "True scientists generally are interested in the technical phases of a company's operations and prefer not to be burdened with the non-technical aspects of the work. However, in order to get ahead, many have had to switch to the administrative side of the business." It was further stated, "The program insures equal advancement opportunities for true researchers and engineering specialists who prefer to stay in their chosen scientific field rather than take line assignments and assume administrative responsibilities. We feel that it will provide us with another important tool to help our research program maintain its healthy growth." Less formal, but what seem to be reliable reports, indicate that mining companies are adopting similar forward looking policies.

The future doubtless will see many other important changes in attitudes, policies, procedures, and practices for more and better utilization of science and engineering. More interest and concern on the part of industry in mineral engineering education is an important and relatively recent trend. If continued, this trend may well provide the solution to future needs through helping our colleges and universities to provide better graduates for more effective use.

In closing, the author wishes to refer to statistics from Russia and West Germany. According to reliable reports, the total number of well-trained engineers in the Soviet Union now approximately equals the total number in the United States. Currently, Russia is graduating two to three times the engineers we do. In addition, the Russian Technicums—comparable to our two-year-colleges—are producing roughly 12 times the technicians we are. In terms of gross national production Russia has roughly 400 engineers per 1 billion dollars as against approximately 60 in this country. Lute J. Parkinson, professor of mining at the Colorado School of Mines, discovered that the colleges of mining engineering in West Germany had enrolled as many mining engineer students as are enrolled in the United States. Yet, tons of ore and rock mined in the United States are far in excess of tons mined in West Germany. In the United States among the larger and smaller industrial areas differing amounts of science and engineering manpower are being used.

How can large differences in quantity use of science and engineering be explained? Are Russia and West Germany using too many engineers or are we not using enough? Are certain domestic industries utilizing too much science and engineering manpower, while others are defficient? In the answer to these important questions lies the crux of the future outlook for mineral engineering manpower in the United States.

These questions are of vital importance to you in industry and to us in education. Government and industry —the users of engineers—must provide the correct answers in the near future.

COAL RESEARCH

(Continued from page 96)

tions on: heat transfer characteristics of coal-water slurries at higher temperatures and pressures; high temperature gas reactions at solid surfaces; kinetic study of the steam-carbon reaction at high temperatures; gasification of a coal-water slurry in an electrically heated coil, and reaction kinetics of the hydrocracking and thermocracking of lignite tar fractions.

Hydrogenation. The American Gas Association, looking forward to the day when supplies of natural gas are inadequate, is engaged in pilot plant process development of high-pressure hydrogasification of a fluidized moving bed of pulverized coal. A 1000 Btu fuel gas is produced and the residual char is further treated to produce the hydrogen required.

Union Carbide, active in coal hydrogenation for many years, with the operation of a semi-commercial prototype plant to make chemical products, is now carrying out investigations on the smallest scale felt to be compatible with heat and mass transfer requirements in a continuous feed unit. Although this work looks toward the production of chemical products, Union Carbide indicates that considerable understanding of the requirements of a synthetic liquid fuels process based on coal is achieved.

The U. S. Bureau of Mines continued to study the mechanism of destructive hydrogenation of coal.

In hydrogenation of coal at 2000 psig, iron and molybdenum catalysts and catalyst concentration were investigated in the pilot plant. Methods for recovering the molybdenum catalyst from the residue are being sought.

Investigation of dry-coal hydrogenation at temperatures up to 800°C and 6000 psi in a semicontinuous unit was concluded. A continuous unit was designed and built for further testing of the process.

Fischer-Tropsch Synthesis. The U. S. Bureau of Mines undertook further work on the Fischer-Tropsch synthesis, including preparation and testing of different types of synthesis gases and catalysts, poisoning of catalysts, and pilot-plant studies of the hot-gas-recycle process.

Other Conversion Projects. North American Coal Corp. is active on a project whose objective is the recovery of alumina from mine wastes.

Penn State is investigating organic binders, particularly coal tar pitches, to better understand which properties of pitch are important for the production of high-quality electrodes for the aluminum, steel, and other industries. It is also conducting research on the possible substitution of selected anthracites for petroleum coke as a filler in amorphous carbon and other products. It cites that the major limitation to such use of anthracite is its high mineral matter content. In an attempt to get high efficiency conversion of the energy in coal to electric power, Pennsylvania State University is conducting fuel cell research. It reports that significant contributions have been made to the understanding of electrode reactions in fuel cells and the role of catalysts in cell electrodes.

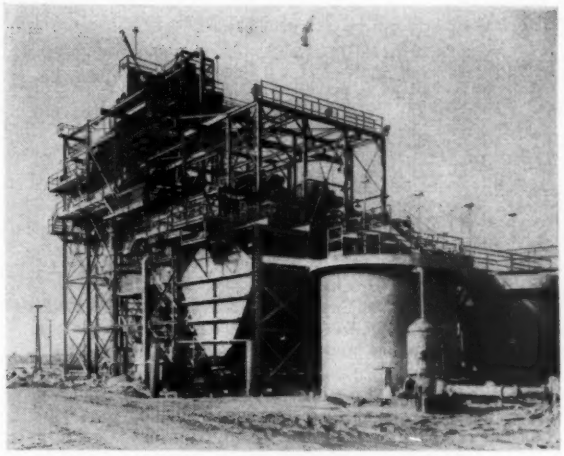
Penn State is also conducting projects on: preparation of highly porous carbons from humic acids derived from nitric acid treatment of bituminous coal; an investigation of the reaction of sulphuric acid with bituminous coal; purification of bituminous coals by solution in aromatic oils and utilization of these coals as a source of organic chemicals, and an investigation of the activation of anthracite to produce an active carbon.

Pittston Co. reports that it has undertaken work on the production of expanded aggregate at its new laboratory in Carbo, Va.

Phosphate Rock

U. S. production is estimated at 15,300,000 long tons—over 40 percent of the world's total output

By C. V. O. HUGHES
Assistant Department Manager
Mining Division
Virginia-Carolina Chemical Corp.



Underflow from the Clear Springs washer of Virginia-Carolina Chemical Corp. is pumped four miles to a flotation plant

WORLD output of phosphate rock during 1958 probably totaled over 34,000,000 long tons. Major producing areas, in order of importance, are: the United States; North Africa; Russia; the Pacific islands; Asia, and South America.

United States production and sales exceeded 15,000,000 long tons in 1958 —over 40 per cent of the world total.

African output, mainly from Morocco and Tunisia, totaled about 9,000,000 long tons. Political factors, even more than economic ones, keep Africa from taking a greater share of the world market.

European production is dominated by Russia. The U.S.S.R. produced well over 5,000,000 long tons, out of a European total of 6,000,000.

Pacific island output comes largely from Makatea, Nauru and Ocean Island in the Western Pacific. It totaled not quite 2,000,000 long tons.

Asia's production scatters from China and Christmas Island to Jordan and Israel. It totaled slightly over 1,000,000 long tons.

South America's total is a little more than 500,000 long tons. It is largely from Peru, Brazil, Chile and Venezuela.

Florida Accounted for 71 Percent of U. S. Output

In the United States, phosphate rock comes from Florida, Tennessee, and the western states (Idaho, Montana, Wyoming and Utah). U. S. production for 1958 is estimated at 15,300,000 long tons; of this, Florida produced 71 per cent, Tennessee over 12 per cent, and the four western states over 16 per cent. Total value of 1958 U.S. production was $100,000,000 at the mines.

Florida's 1958 production is estimated at 10,800,000 long tons. Almost all of this comes from the "land pebble" field of Polk and Hillsborough counties, in central Florida. Eight mining companies operate in this area. These are American Agricultural Chemical, American Cyanamid, Armour, Coronet Phosphate, Davison Chemical, International Minerals & Chemicals, Swift, and Virginia-Carolina Chemical.

American Agricultural Chemical placed a new 20 cu yd dragline in operation at its South Pierce mine in November 1958. It now operates four draglines at South Pierce; the 20 cu yd machine, one 17 cu yd and two 9 cu yd. At its Boyette mine and flotation plant, tables were replaced with a 60 in. by a 75 ft rougher belt for handling the coarser fraction of flotation feed. Boyette operates two 9 cu yd draglines. Both mines operated on a five-day week during 1958.

American Cyanamid added a new 9 ft by 80 ft rotary dryer at its Brewster rock preparation plant. No significant changes were made at its two mines—Sidney and Orange Park. Except for a short inventory adjustment period, all these facilities operated on a five-day week. The 200,000-ton triple superphosphate plant was on a seven-day week.

Armour made no changes. The company operated its Bartow mine and processing plants on a five-day week. The triple superphosphate plant operated on a seven-day week during the year.

Coronet Phosphate operated its Teñoroc mine and processing plant on a five-day week during 1958. No major changes or additions were reported. The bank of eight 24-in. Dorrclones, installed in 1957, outperformed the 150-ft hydroseparator in recovery of fine flotation feed.

Davison Chemical installed a new 8 ft by 80 ft rotary dryer at its Ridgewood rock preparation plant. Some storage capacity was added at its 200,000-ton triple superphosphate plant, for denning part of the product. No changes were made at its two mines, Pauway and Bonnie, nor at the beneficiation plants at these mines. The mines operated on a five-day week, and the triple superphosphate plant on a seven-day week.

International Minerals & Chemicals operated its Noralyn mine on a seven-day week, and its Achan mine on a five-day week. At Noralyn, a 21 cu yd and 26 cu yd dragline worked together to supply the plant. Matrix was pumped more than four miles to the beneficiation plant. Pipelines are being changed from 16 in. to 18 in. diameter to handle higher throughput.

C. V. O. Hughes is a mining engineer, trained at Columbia University. He has worked in Pennsylvania steel mills, in consulting work in New York, in the Missouri lead mines, and in California, Oregon, Nevada and Washington as a miner and processor of nonmetallics. He joined Virginia-Carolina Chemical Corp. in 1951.

Hydraulic mining at the Noralyn mine of International Minerals & Chemical Corp. A 21 cu yd and a 26 cu yd dragline work together to supply the plant

No changes were made at Achan. The Bonnie Chemical (triple superphosphate) plant operated at full capacity. A sizeable expansion of this plant is now in the design stage.

Swift put a new 14 cu yd dragline into operation in January 1958. It has replaced a nine cu yd dragline at the Watson mine. The Watson and Varn mines worked on a 7-day week schedule all year. No other changes were made at these mines, or at Swift's central processing plant at Agricola. The triple superphosphate plant ran at capacity during 1958.

Virginia-Carolina Chemical Corp. reactivated dragline mining at both the Clear Springs mine and the Homeland mine during 1958. Three draglines are in operation—two 17 cu yd and one 8 cu yd. The 17 cu yd dragline at Clear Springs crossed to the east side of Peace River in August 1958. Flotation feed underflow from the Clear Springs washer is pumped four miles to the Homeland flotation plant. Mining and washing at Clear Springs were on a seven-day week. Homeland flotation went to a seven-day week in December 1958. No changes were made at the Nichols rock preparation plant. The triple superphosphate plant operated at capacity during the year.

Four Producing States in West

Western States' production continued to grow. This is a large field, but with some serious problems in grade, in susceptibility to beneficiation, in location and transportation, and in mining costs for certain of the deposits. In order of tonnage output, the four producing states are Idaho, Montana, Utah and Wyoming. Total production from these four states is estimated at 2,600,000 long tons of mined rock in 1958. There was some beneficiation after mining, so that the tonnage at the point of use may have been as low as 2,300,000 tons.

Idaho. J. R. Simplot Co. shipped rock from the Gay mine to Pocatello, 30 miles south, for use both in Westvaco's electric furnaces and in Simplot's triple superphosphate plant. Monsanto mined its Ballard open pit and shipped rock to its electric furnaces nearby at Soda Springs. San Francisco Chemical Co. produced a small tonnage of high grade rock at its Waterloo mine. Anaconda operated its open pit Conda mine near Soda Springs; the entire output goes to its fertilizer plants at Anaconda, Mont. Central Farmers Fertilizer Co. started mining in Georgetown Canyon, near Georgetown, Idaho, in September 1958. The rock is transported to Phosphoria Gulch, where an electric furnace is under construction; one feature of this transportation is a two-mile belt conveyor handling 400 tph.

Montana. Victor Chemical Co. mined underground at its Canyon Creek and Maiden Rock mines, and shipped the rock 30 miles north to Silver Bow. At Silver Bow, the rock is beneficiated and fed to electric furnaces. Montana Phosphate Products Co. mined both underground and open pit at its Anderson and Luke Mines; the entire output is exported to Trail, B.C. J. R. Simplot Co. operated its Centennial open pit on the Montana-Idaho border; the output goes to Northwest Chemicals in Medicine Hat, Canada. Relyea had an intermittent production at its small independent mine.

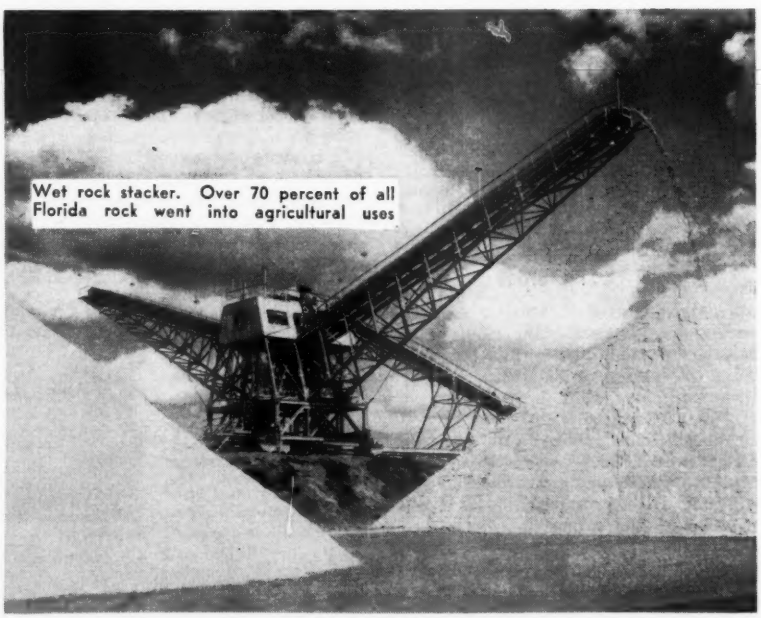
Utah. San Francisco Chemical Co. developed its Cherokee underground mine, six miles south of its flotation plant at Leefe, Wyo. The rock goes to Leefe for treatment. San Francisco Chemical also operates another underground mine in northern Utah, and has additional property under option near Vernal, Utah.

Wyoming. San Francisco Chemical operates an open pit mine at Leefe, where it has a 1000 tpd beneficiation plant. Phosphate rock from across the border in Utah also is treated at Leefe.

Over 75 Percent of Tennessee Rock Went Into Electric Furnaces

Tennessee produced the equivalent of 1,900,000 long tons of marketable rock. Run-of-mine rock totaled about 3,000,000 tons; part of this was washed to marketable grade, and part was used in electric furnaces without washing. Over 60 per cent of electric furnace feed was washed rock, and nearly 40 per cent was raw run-of-mine rock ("matrix").

(Continued on page 117)



Wet rock stacker. Over 70 percent of all Florida rock went into agricultural uses

A record production of over 4,350,000 tons of ore, the opening of nine new mills and indications of the beginning of a commercial market marked 1958 as a banner year for the uranium industry

Uranium

By W. SPENCER HUTCHINSON, JR.
Assistant to the Manager
Grand Junction Operations Office
U. S. Atomic Energy Commission

A NUMBER of significant developments and changes occurred in the domestic uranium raw materials procurement program in 1958. These include several important announcements by the U. S. Atomic Energy Commission, a continued increase in ore production in the western United States, new mills going into operation, and the expected increase in concentrate receipts.

The total uranium concentrate production received at Grand Junction, Colo., for the 1958 Fiscal Year ending June 30, 1958, amounted to 10,111 tons of U_3O_8. This was approximately a 35 percent increase over uranium concentrate production in Fiscal Year 1957. The total domestic production included an additional 150 tons produced as by-products in the chemical processing of Florida phosphate rocks, from the treatment of Idaho euxenite, and from reprocessing of refinery residues at a plant in Cannonsburg, Pa.

During this same period, domestic uranium mines produced and marketed 4,353,000 tons of ore, a 30 percent increase over production in Fiscal Year 1957. Domestic uranium mills treated a total of 4,362,000 tons of ore in Fiscal Year 1958, resulting in a close balance between ore production and ore processed. Stockpiles of uranium ore above the ground remained at nearly 2,000,000 tons.

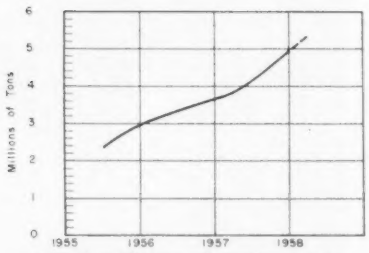
There are now 23 uranium processing mills in operation in the western United States. Nine of these mills went into production in 1958. The most recent mills to go on stream were the Phillips Petroleum Co. mill, the Homestake-Sapin mill, and the Kermac mill in the Grants area of New Mexico; the Lakeview mill at Lakeview, Ore., and the Fremont mill at Riverton, Wyo. These 23 mills have a total rated capacity of about 21,000 tpd of ore, and the estimated total capital cost is $134,928,000. In addition to the foregoing full-scale mills, Cotter Corp., placed its pilot plant at Canon City, Colo., on stream in July 1958.

Brakes Put on Further Expansion

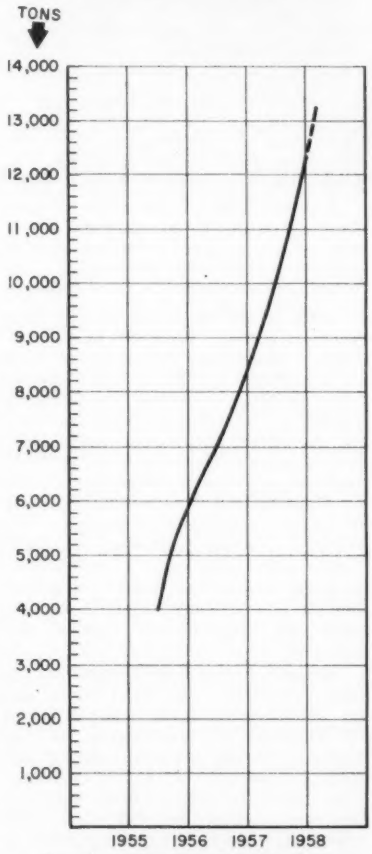
The announcement made by Jesse C. Johnson, director of the Division of Raw Materials, in New York on October 28, 1957, was the most significant policy statement made in 1957. As early as 1955 and in several subsequent statements, it had been indicated that the uranium supply was approaching the point where it would be adequate for the military and power requirements as projected for the next few years. However, in the New York announcement, industry was informed that the time to limit further expansion of domestic production had arrived. It was emphasized that this was not a cutback, but putting the brakes on further expansion in order to hold the annual supplies in a reasonable relationship with the requirements.

The October 28, 1957, speech inspired a long series of industry meetings, mining association statements, and representations made to members of Congress, especially the Joint Committee on Atomic Energy. The New Mexico Economic Development Commission held a meeting at Albuquerque on December 9, 1957, at

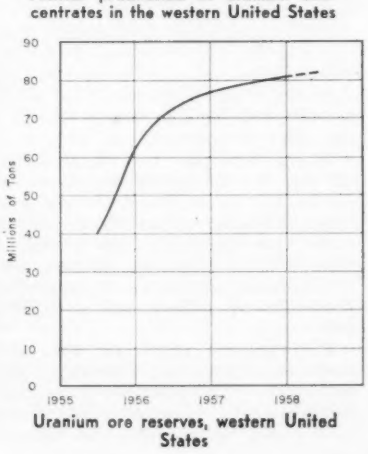
W. Spencer Hutchinson, Jr., received his degree in mining engineering at Massachusetts Institute of Technology. His career has included nearly 20 years of operating experience in the domestic mining industry. Since 1949 he has been with the staff of the U. S. Atomic Energy Commission at Grand Junction, Colo., and was appointed assistant manager in 1951—later revised to assistant to the manager.



Annual production of uranium ore in the western United States



Annual production of uranium concentrates in the western United States



Uranium ore reserves, western United States

Underground equipment varies from large front-end type tractor loaders to small wheelbarrows, depending on the size of the operation

which many of the industry's troubles were aired at length.

At the National Western Mining Conference in Denver on February 7, 1958, Johnson appeared again and explained further the Commission's objectives in limiting further expansion.

"One of the results of the October announcement," Johnson said, "has been a recognition on the part of the uranium industry that some limitation on expansion of uranium production is needed. Excessive production could be supported only by a Government stockpiling program, and experience indicates that the uncertainties of such a program are not conducive to a stable, forward planning industry. We want a strong continuing domestic uranium industry, and to the extent possible, production should not go beyond the level that can be sustained until the commercial market develops."

Meanwhile, the Joint Committee became interested in the subject and on February 19, 1958, began a series of hearings in Washington on the problems of the uranium mining and milling industry. At about the same time, industry was advised that the Division of Raw Materials was conducting a survey of reported cases of hardship and would publish a written report at an early date.

This report entitled, "Domestic Mining and Milling Problems Resulting from Limitation on Additional Milling Capacity," was made public on April 2, 1958, both by the Commission and the Joint Committee.

Using November 1, 1957, as a cut-off date for the tabulation of ore reserves, the report listed five uranium areas as having no local market, or an inadequate market, for the output of mines with developed ore reserves, and it estimated minimum requirements for additional mill capacities of 3300 tons.

The deficient areas and the estimated tonnages were: Wyoming 1700; southeast Texas, 600; North Dakota-South Dakota (lignites), 600; Colorado Front Range, 200; and Nevada (Austin), 200. The report also listed six other areas which were described as having adequate mill capacity if it could be distributed equitably among the mining properties, and five other areas where there appeared to be no marketing problems now and no problems anticipated.

Assuring Fair Portion of Market for All Poses Problems

This announcement of a limited expansion, which would add more than 3000 tpd capacity to the 21,000 tpd total for the mills now in operation was received with favorable comment by a major portion of the industry. The release of the report opened the way for the resumption of milling negotiations at the Grand Junction Operations Office between the Commission and private industry to provide minimum mill capacities in the deficient areas. However, arranging for limited additional milling capacities and at the same time assuring a fair portion of the market for all ore producers in an area presents new problems to the industry that are not readily or easily resolved.

Progress is being made in contract negotiations to adjust the ore market in areas having adequate mill capacity but needing an equitable distribution among the mining properties. As an example, announcement was made in August 1958 of the extension to 1966 of the Texas-Zinc Minerals Corp. contract covering operation of the mill at Mexican Hat, Utah, which also included arrangements for treating a much larger quantity of ore produced by independent mine operators. These arrangements provide a mill capacity available to independent miners in this area consistent with the portion of November 1, 1957, ore reserves in their properties.

The Commission is negotiating for contract extensions through 1966. Some fears have been expressed by the independent miners that they will not have a market for their ores after March 1962. These fears are not well founded. The Commission expects to provide a market for independent ores in all contracts which may be extended to 1966. Until 1962, the established ore price will be a part of the negotiated price. After 1962, the economics insofar as the price for ore, haulage, etc., will be an arrangement between the mill and the mine operator.

The limitation of markets for the independent mine operator has been confined to only a few areas. With the exception of the districts where milling capacity was obviously inadequate, any limitation of market has been temporary due to the delay by starting of the new mills in the past 12 months.

Announcement was made in August that the Commission would discontinue buying uranium ore at Grants, N. M., on October 1, 1958, since several private firms were operating and providing a market to independent ore producers in the area. After October 1, 1958, the Commission was operating only one buying station at Monticello, Utah, where limited quantities of uranium ores are purchased under the provisions of Domestic Uranium Program Circular 5, Revised. In July 1958 the Commission purchased only two percent of the total ore produced, and private industry the other 98 percent, which shows the susbtantial change to a private buyers market. July ore deliveries represented an annual production rate of nearly 5,500,000 tons.

AEC 1962-1966 Purchase Program Modified

The following notice modifying the Atomic Energy Commission's 1962-1966 Uranium Concentrate Purchase Program was filed November 24, 1958, with the U. S. Federal Register by the U. S. Atomic Energy Commission.

"1. On May 24, 1956 the Atomic Energy Commission announced that it would guarantee the purchase of U_3O_8 in concentrates produced and delivered during the period April 1, 1962—December 31, 1966. The Commission will carry out its May 24, 1956 commitment with respect to ore reserves developed prior to this date in reliance

Uranium requirements of AEC will in themselves assure a high level of domestic production through 1966

upon the May 24, 1956 announcement by negotiating for the purchase of appropriate quantities of concentrates derived from such ore reserves during the 1962-1966 period. Such purchases will be at the previously established price of $8.00 per pound for U_3O_8 in an acceptable concentrate.

"2. By issuance of this announcement the Atomic Energy Commission hereby withdraws prospectively the concentrate purchase program announced May 24, 1956. With respect to new ore reserves developed after this date, the Commission will make contracts to purchase concentrates to the extent that requirements dictate and on such terms and conditions and at such prices as the Commission may from time to time agree upon. Future programs will give due consideration to the adequacy of domestic ore reserves, the need for exploration and development, the maintenance of the domestic uranium industry, and other factors which may be important to the Atomic Energy Program.

"3. The effect of this modification will be to provide the domestic uranium industry with a substantial continuing market for the period 1962-1966 for concentrates derived from already developed ore reserves and, at the same time, guard against overproduction.

"4. Under this revised program, the Commission's 1962-1966 domestic uranium concentrate purchases from ore reserves already developed will be limited to:

(A) Current milling contracts;
(B) Appropriate extensions of current milling contracts to the extent the Commission determines that the milling facilities are needed for the presently existing mining operations and developed ore reserves;
(C) New milling contracts or amendments to existing contracts which may be executed pursuant to the Commission's April 2, 1958 announcement of the limited expansion of the domestic uranium procurement program;
(D) New milling contracts or contract amendments which may be negotiated for the purchase of appropriate quantities of concentrates in the 1962-1966 period from ore reserves developed between November 1, 1957 and the date hereof.

"5. The action taken today is to guard against serious overproduction which might occur under an unlimited purchase program if very large additional uranium discoveries are made. The Commission's action recognizes the need for placing definite limitations on annual deliveries of concentrate and at the same time it gives due consideration to those who already have developed ore reserves in reliance upon the Commission's 1956 announcement. Protection will be given the independent miners by incorporating in all new milling contracts and extensions to existing milling contracts provisions designed to provide independent mine owners a fair share of available milling capacities.

"6. Today's action is not due to any forecast of a reduction in the Commission's uranium requirements or in the potential requirements for commercial atomic power. However, it is in the best interest of both the industry and the government to hold uranium production in reasonable balance with requirements."

Initially Commercial Market Will Be for Concentrates

Additional encouragement for the uranium industry came on May 8, 1958, when the Commission announced in general terms the conditions under which private sales of uranium ores and concentrates by domestic producers will be authorized. Licenses may be granted on application under the existing regulations. Sales under this program may be made either to domestic or to foreign buyers for peaceful uses of the materials, but as is the case with all uranium products, sales will be subject to licensing by the Commission.

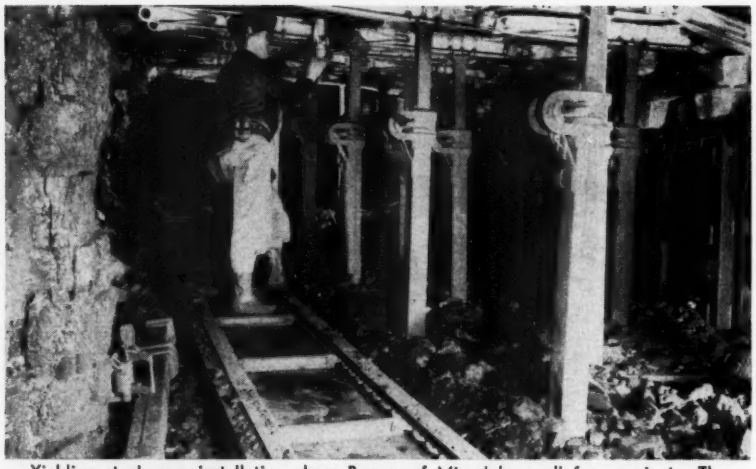
Uranium for private sales may come from existing mills having a production capacity in excess of that required to meet deliveries under Commission contract, or from expanded facilities constructed to supply the commercial market. Also, the Commission will consider releasing uranium which it has already under contract for its own use, subject to such modification of contract as may be deemed appropriate. Eleven of the Commission's milling contracts have been modified to include arrangements to release U_3O_8 for sale to a properly licensed private buyer. All other contracts are in the process of modification to include similar arrangements. This further step toward a normal commercial market for uranium producers will make it possible for U. S. industry to compete with other suppliers for the growing foreign and domestic markets for nuclear fuel.

In recent months there have been indications of the beginning of a commercial market. It is believed that every company now producing has received inquiries from domestic and foreign purchasers relative to the sale of small lots of concentrate. While it appears that the present market is for small amounts for test purposes, in several instances substantial amounts were mentioned as being needed in the future.

The commercial market, initially at least, will be for concentrates. AEC purchases after March 31, 1962, will also be confined to concentrates in order to conform to private industry practice. Based on recent studies it appears that the domestic industry should be in a good position to compete at home and abroad with other uranium producing nations as a commercial market develops.

During the fiscal year ending June 30, 1958, domestic production of uranium concentrates was slightly more than 10,000 tons of U_3O_8. Domestic production in this fiscal year is expected to be between 14,000 and 15,000 tons, a very substantial increase.

Atomic power will call for a major expansion of the uranium industry. However, it cannot be predicted with certainty just when atomic power requirements will have an important impact on uranium production. It is hoped that by 1966 the consumption of uranium to cover atomic power requirements will reach substantial proportions. The Atomic Energy Commission's uranium requirements, which are now being covered by firm contracts, will in themselves assure a high level of domestic production through 1966.



Yielding steel prop installation along Bureau of Mines' longwall face project. The Bureau and a cooperating company propose first to develop a mechanized system of roof support for relatively flatbed mining and then to extend the system to more steeply pitching seams

Anthracite

A sharp break in export markets and depressed business conditions were largely responsible for decreased anthracite sales in 1958 as compared with 1957. Promising research in new uses for anthracite and the current upswing in business give the industry renewed hope for 1959

By J. A. CORGAN
Chief, Division of Anthracite
U. S. Bureau of Mines

A joint $17,000,000 program for mine-water control in the anthracite region was established in 1955 by the Federal Government and the Commonwealth of Pennsylvania. By the close of 1958, 22 projects with a total cost, contracted or estimated, of $8,000,000 had been approved

OWING to a combination of generally unfavorable economic factors, production of Pennsylvania anthracite dropped to approximately 21,500,000 net tons in 1958, 15 percent less than in 1957. A sharp break in export markets, both in Canada and Europe, and depressed business conditions played major roles in the decline.

A size study of estimated production for 1958 paints a revealing picture of various markets during the year. For several years the smaller industrial sizes have displayed relatively greater market strength than the larger space-heating sizes. However, this trend was reversed sharply in 1958 since, at the close of the year, output of Pea and larger was running about 20 percent below 1957 levels, but Buckwheat No. 1 and smaller was about 23 percent less. Within the Buckwheat range, the declines varied from approximately 15 percent for No. 1 and 2 (Rice) to about 28 percent for Buckwheat No. 3 (Barley) and smaller.

As 85 to 95 percent of annual exports to Canada consist of the larger sizes, the sharp break in the production of the smaller coals was triggered by decreased demand in Western European and American markets. In the United States, coke production in 1958 was down approximately 30 percent, with a similar decline in the quantity of anthracite used for blending. Similarly, sharp reductions in steel operations depressed metallurgical markets for anthracite. While 885,000 tons were reported used in sintering and pelletizing operations in 1957, the amount used for these purposes was undoubtedly far less in 1958 because of the decline in steel output. Electric power utilities, anthracite's largest customer, reduced their anthracite burn by about 20 percent in response to decreased industrial demand for electricity, while railroads sliced consumption approximately eight percent.

Although retail dealers maintained yard stocks near 1957 levels throughout much of 1958, retail deliveries for the year dropped 15 percent, compared with a production decline of 20 percent in Pea and larger sizes. However, the extremely cold weather that gripped the major part of the Nation during the last two months of the year, undoubtedly drastically reduced stocks in consumers bins, in retail yards, and at the mines. Consequently, production during the first quarter of 1959, should equal, if not actually exceed, that for the same period of 1958.

The latest figures available indicate that exports for 1958 totaled about 2,400,000 tons, compared with 4,300,000 tons in 1957. The significance of this decline to the anthracite industry is better illustrated, perhaps, by pointing out that while export markets took 1 of every 5½ tons produced in

1956, the ratio of exports to production sank to 1:8 in 1958.

Exports to Canada in 1958 are expected to total approximately 1,600,000 tons; Europe, 725,000 tons, and all other overseas destinations, 100,000 tons. These figures represent declines from 1957 of more than 200,000 tons in the Canadian market, 1,600,000 in Europe, and 100,000 tons for all other countries.

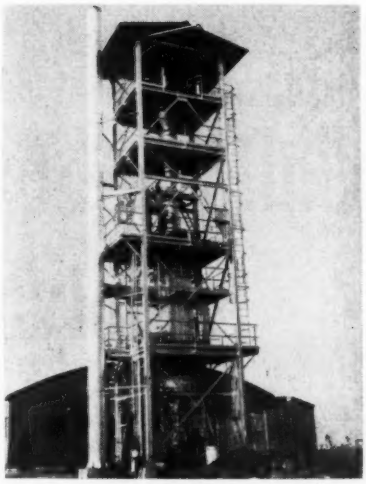
Canadian demand for American anthracite has decreased primarily for the same reason as in the United States—competition of other fuels and general economic conditions. The decline in the over-all demand for Pennsylvania anthracite in overseas markets during 1958 may be attributed to several reasons. Although all are not applicable to each country, the increased availability of domestic coal, a relatively warm winter in 1957-58, overstocking during 1957, competition of Russian and other anthracites, and the desire to conserve dollars, are the factors thought to be most responsible for reducing imports from the United States.

Utilization and Preparation Research

At the Anthracite Experiment Station of the Bureau of Mines, Schuylkill Haven, Pa., both fundamental and applied research were conducted during 1958 on the utilization and preparation of anthracite. The fundamental work is concerned chiefly with exploring the physical and chemical characteristics of anthracite. As part of this work, studies were continued on the effect of nitric acid oxidation on anthracite and arrangements were made to study the effect of gamma and neutron radiation. Fifty-gram samples of minus-60 plus-140-mesh anthracite will be used in these radiation tests.

In efforts to produce a thermally-stable anthracite for metallurgical purposes, various lump-size anthracites were heat-treated in a vertical-shaft calcining pilot plant at the Experiment Station. The tests showed that certain anthracites tend to be more sensitive to decrepitation than others, a characteristic which appears to vary with the volatile-matter content of the feed material.

Bureau research on producing an agglomerated anthracite metallurgical fuel demonstrated that a mixture of approximately 82 percent anthracite, 10 percent bituminous coal, and an 8 percent 70°C-melting coal-tar pitch, would produce a briquet comparable in ASTM tumbler stability with premium cokes. These test briquets were formed at approximately 3000 psi and calcined at 889° C for three hours. Tests conducted on different formulas established that stable briquets could be produced from mixes containing no bitumious coal; however, to do so the coal-tar pitch content had to be increased to a range of from 10 to



In efforts to produce a thermally-stable anthracite for metallurgical purposes, various lump-size anthracites were heat-treated in a vertical-shaft calcining pilot plant at the Anthracite Experiment Station. Tests showed that certain anthracites tend to be more sensitive to decrepitation than others

12 percent. Various other coal-tar pitches and asphalt-residue binders also were examined during the experiments. In addition, preliminary tests were completed on calcining briquets in the pilot-plant calciner.

Calcined anthracite has been tested in three commercial foundries during the last 18 months. Two of the foundries have operated previously with anthracite, hence the use of the calcined material presented no difficulties. In both such installations, satisfactory metal temperatures and melting rates were obtained with the calcined anthracite. However, as the iron produced in these foundries does not need to meet rigid specifications, final determination of whether calcined anthracite can replace coke in all types of cupola operations must await completion of tests being carried on in a third foundry which specializes in high-quality merchant production.

Author of numerous papers on coal research and economics, Joseph A. Corgan has specialized for more than two decades in research and the economics of coal, coke and other fuels. Early experience included six years in the anthracite utilization activities of Hudson Coal Co. and three years with National Bituminous Coal Commission. His association with the Bureau of Mines began in 1940, when he was appointed mineral economist in the Coal Economics Branch. During the next several years he was promoted to positions of increasing responsibility, becoming chief of the Division of Anthracite in 1955. This division is responsible for planning and developing long and short range scientific and technological research programs.

The preparation laboratory has been expanded during the past year at the Anthracite Experiment Station. It is now possible to make complete washability tests, experiment on heavy-media preparation, study cyclones as cleaning and sizing agents, and investigate froth flotation as a fine-coal cleaning process. An air-swept ball-mill pilot plant also has been installed at the Station to study the fine-grinding of anthracite, and tests were conducted to determine the effect of size on ash content.

Because heavy-media preparation of fine anthracite requires precise density controls, the necessary equipment was obtained. Washability tests were completed on Holmes and Mammoth seam anthracites and the resulting information is being compiled for a Bureau report.

Mining Research

In the field of anthracite-mining research, the Bureau recently completed preliminary trials of its vibrating-blade planer in a seam of moderately-pitching coal. The advantages of collapsible steel mine props have been demonstrated and studies also have been conducted on applying pneumatic rock stowing to the recovery of pillar coal. Owing to the high labor costs involved in installing and moving mine props, this work will be furthered by inquiring into the adaptability of European-type hydraulic props to long-wall mining in the anthracite fields.

During 1958 a fully-mechanized long-wall mining system was established in an active mine of a cooperating producer. After work has been completed with a rigid-blade planer, a German-made drum-type loader will be installed and thoroughly tested to determine its ability to cut and load hard anthracite. For this same project, a vibrating-blade planer will be used to determine its usefulness in mining by the long-wall system.

In connection with investigations of mechanical mining, the Bureau and the cooperating company propose, first to develop a mechanized system of roof support for relatively flat-bed mining, and then to extend the system to more steeply-pitching seams. This type of roof support should result in more complete roof control, greater coal recovery, lower costs, and added safety for face workers.

A project was started, also in cooperation with an anthracite company, to develop and test large-diameter boring equipment for driving chutes and gangways in steeply-pitched areas. In conjunction with this project, a metal shielding device to protect face workers will be designed and tested.

A study continued in 1958 on using hydraulic methods for hoisting an-

(Continued on page 121)

Predictions for 1959 are for moderate improvement in production and consumption of . . .

Molybdenum

FREE-WORLD production of molybdenum decreased in 1958 in response to economic conditions, but the United States maintained its position as by far the largest producer:

	Millions of Pounds of Molybdenum (Concentrate)		
	1956	1957	1958 (estd.)
Free world including USA	63	67	44
USA alone ...	57	61	40

The largest individual mine, at Climax, Colo., was struck by labor for about 2½ months. Effects were minor because a high rate of operations before the strike had provided sufficient inventory to meet demand.

The apparent free-world industrial consumption also decreased in 1958 as compared to previous years:

	Millions of Pounds of Molybdenum		
	1956	1957	1958 (estd.)
Free world ...	62	60	44
USA	39	35	27
Outside USA .	23	25	17

The figures for apparent industrial consumption outside the United States are based on foreign production and USA exports. The low apparent 1958 value is attributed in part to drawing down of inventories previously built up. Three countries — Great Britain, Germany and France — account for about three-quarters of the free world's consumption outside the United States.

Molybdenum Chemistry

Two items are of interest in the development of molybdenum chemistry in 1958: development of a proprietary product utilizing molybdenum as a trace element in plant growth, and the expansion of molybdenum disulfide chassis greases to the passenger car market.

The agricultural product has been formulated specifically for seed treatment of legumes—soybeans, peanuts, alfalfa, clover, and peas—crops which show dramatic responses to molybdenum because of the latter's function in catalyzing the fixation of nitrogen. Crop increases of as much as 25-50 percent have been obtained. The seed treatment product, which can be applied at the time of inoculation, is the forerunner of two more products, designed for top dressing and foliar spray. It is now being test-marketed in three areas of the United States.

The past year also saw the introduction of Molysulfide chassis greases to the passenger car market by a major oil company in the Southeast. Previously limited to commercial truckers, Molysulfide greases may now find an entirely new and large volume market by extending the benefits of reduced wear, easier steering and more comfortable riding to the average driver.

Metallic Molybdenum

There has been a surge in demand for metallic molybdenum. While molybdenum metal has been used commercially for over 40 years, earlier applications were largely for relatively small electric and electronic parts. Since World War II, molybdenum metal has gained importance in other fields. The success of molybdenum glass-melting electrodes led the producing industry to develop methods capable of making large parts. Most recent development, accounting for much of the accelerated demand in 1958, has been molybdenum's use in large forgings for numerous applications where its high melting point, as well as its stiffness, resistance to erosion and hardness at high temperatures have been decisive properties.

At the end of 1958, the original producer of vacuum-melted molybdenum moved its operations from a pilot plant to a commercial plant, which is now entering full production. A second company started vacuum-melting molybdenum and is working on an imaginative plant where all processing will be carried out under protective atmospheres. A third company made limited amounts under contract. Meanwhile, the numerous companies producing molybdenum by powder-metallurgy methods have opened a new era for their product by markedly increasing the maximum weight and size that they can make.

Research work in the metallic-molybdenum field continues active, with particular stress on development of molybdenum-base alloys with higher recrystallization and melting points than presently available alloys. Meanwhile, a number of firms are investigating production and properties of relatively thin molybdenum coatings. Molybdenum metal cannot be electrodeposited from aqueous solutions, but can be deposited by various other means including metallizing, electrophoretic, vapor deposition, sputtering and vacuum evaporation. Metallized or sprayed coatings of molybdenum have found constantly new applications since they first became commercial about ten years ago. Metallized molybdenum coatings have remarkable wear resistance and excellent bonding properties; they have some porosity, however, and are not suitable for corrosion resistance. Much interest at the moment is centering around vapor-deposited molybdenum coatings, which appear to have corrosion-resistant characteristics similar to those of solid molybdenum. Vapor deposition can be done by hydrogen reduction of molybdenum pentachloride or thermal decomposition of molybdenum carbonyl; both compounds have become commercially available during the past year. The suitability of such plates for various applications is being determined.

While the intensive research and development activities are directed largely towards defense applications, the results will be beneficial in promoting future peace-time uses of mo-

(Continued on page 115)

Strategic Minerals

DOMESTIC producers of strategic minerals have had an uphill pull against foreign imports and decreased demand. Presently there are a few bright spots, but the future outlook for some commodities, such as mercury and fluorspar, is dim —particularly in view of the termination of General Service Administration purchases for the Government stockpile.

By F. A. McGONIGLE
Vice President
Howe Sound Co.

F. A. McGonigle was graduated from University of Idaho's College of Mines, and gained his early experience in the Coeur d'Alene and Butte Districts. After managing mines in South America and Canada, he returned to this country and served as vice president and general manager of Manganese, Inc. McGonigle is now vice president of Howe Sound Co.

Manganese

Domestic production of manganese did not decline too greatly in 1958 because of the GSA carlot purchase program, which is scheduled for completion in late 1959, was still in effect. By November 30, 1958, about 21,600,000 long ton units had been delivered to the GSA. On the other hand, the Butte buying station filled its quota of low grade ore last May and shut down. Production last year was at an annual rate of about 308,000 short tons compared to 364,000 short tons for 1957. Domestic consumption was at an indicated annual rate of 1,630,000 short tons compared to 2,106,000 tons for last year. Manganese consumption parallels steel output.

Imports for consumption last year were at an annual rate of about 3,000,000 short tons compared to the 1957 figure of 3,113,979 short tons. This nominal decrease was an outgrowth of deliveries on contracts negotiated some time ago. With more than ample stocks on hand, the steel companies were not placing new contracts during 1958.

Year end quotes on ore were in the range of $0.915 to $0.965 per long ton unit, duty excluded, although some 48 percent ore had been offered for less than $0.90 per ltu. This was a substantial drop from the 1957 high of around $1.69 per ltu. In November, 1958 the Indian government eliminated the export tax of about $0.135 per ltu on ore.

Preliminary figures indicated that again in 1958 Brazil shipped this country the largest tonnage of ore. India should be in second place as a supplier, although the Minister for Steel, Mines, and Fuel announced last August that 82 mines closed in 1958 to make a total of 136 closures since the beginning of 1957. Too much low grade ore coupled with low prices offset the advantage of lower ocean freight rates, and caused the closures.

The El Paso stockpile of ore had few bidders. The story is that the company which submitted the highest bid is now negotiating with GSA to close the deal.

One much-rumored barter deal for Indian manganese still has not been realized. Apparently, quantity, quality, and price of the ore are prime factors in the delay.

There have been rumblings in news items that the Russians may attempt to undermine prices of non-ferrous metals on the international market. Manganese ore is susceptible to such action, since out of the total world's reserves of 900,000,000 tons, the Soviets have 578,000,000 tons analyzing in the 28 to 50 percent range.

Antimony

Domestic production from antimony producing mines in 1957 was 45 short tons of metal and 644 short tons of impure cathode metal—a total of 689 short tons. The trend for 1958, based on reports for nine months, was about the same, at 839 tons. Comparable figures for domestic prime smelter production were 11,600 tons and 10,600 tons respectively. Secondary production in 1957 was 23,000 tons and the 1958 rate appeared to be about the same.

Consumption of primary metal for 1958 was down 16 percent from the 12,000 ton figure for 1957, the amount reported for six months being 4987 short tons.

Imports for last year were at a projected annual rate of 7500 short tons versus the 16,469 short tons reported for 1957.

Prices over the past several months have been steady at 31 to 32 cents per lb. This is considerably higher than the duty paid foreign price of 24 to 25 cents a lb. The U. S. duty on the metal is six percent of U. S. price; on the oxide it is four percent. Ores and concentrates enter free.

Columbium-Tantalum

Domestic production in 1957 of columbium-tantalum concentrate shipped from the mines was 370,483 pounds, practically all of which came from Porter Brothers' operation in Idaho and was purchased by the GSA. No figures are available for production last year, but indications are that output was about the same. Domestic consumption in 1957 was 890 tons of Cb-Ta metal and it appears that consumption for last year is somewhat less, although figures are not obtainable. Current quotes are $1.05 to $1.10 per lb for the 10 to 1 ratio pentoxide, 65 percent Cb_2O_5, and $0.95 to $1.00 per lb for the 8.5 to 1 ratio.

Imports for 1957 of natural columbium and synthetic concentrates were 3,348,706 lb. For tantalum in terms of concentrates there were 828,265 lb imported. No figures are available for imports in 1958.

Tantalum is used largely for its corrosion resistance property, and its consumption is growing in the electronics field, particularly for capaci-

tors. It is best suited for miniaturization, for temperature range variations, shock, and acceleration conditions. This metal is not in too abundant supply in the world. Its partner, columbium, has its main use in ferro alloys, and is gaining use in low carbon steel and certain high temperature alloys. Tantalum, if it were in larger supply, also would find an important place for the latter purpose. There are interesting possibilities for the use of both metals in the nuclear energy field.

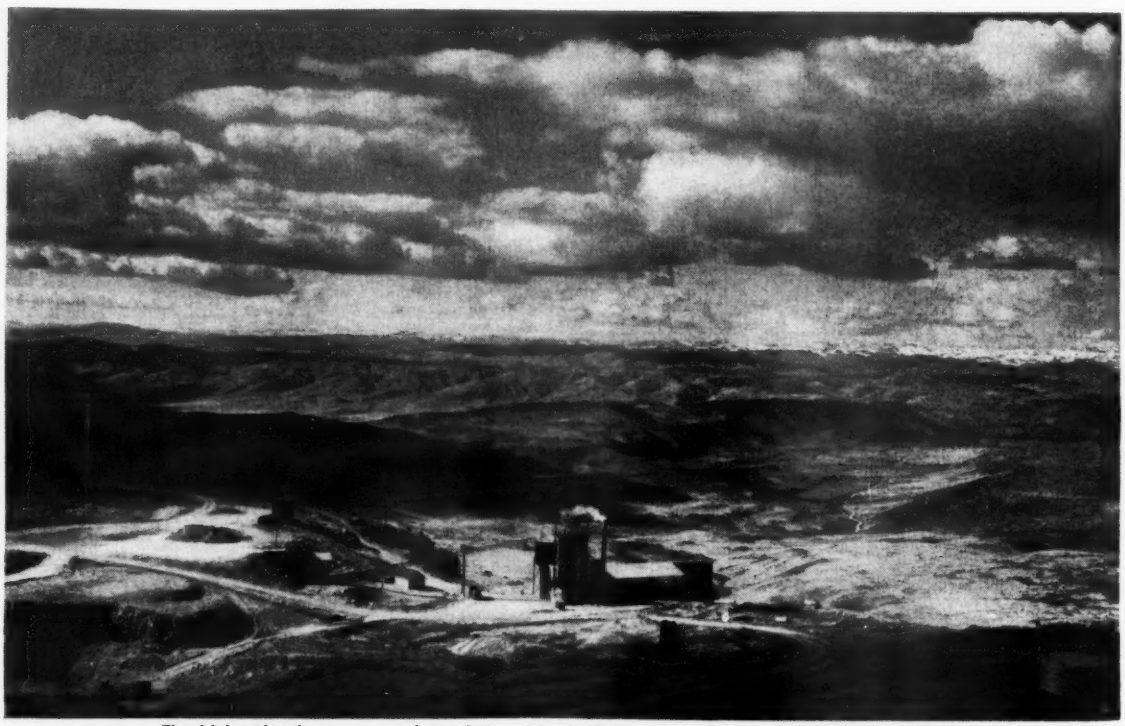
mand for this metal in high-temperature and high-strength materials, permanent magnet alloys, salts and driers, high speed steels, cutting and wear resisting materials and other uses.

The future of the domestic cobalt industry is dismal indeed. When the present producers fulfill their government contracts, domestic production, except that from scrap metal, will cease. None of them can compete costwise with the Belgian, Cuban, Canadian or Moroccan mines, and once

by-product from one other mine. If competitive conditions as exist today with foreign producers continue much longer, domestic producers may number three or less and once again this country will not be self-sufficient in this vital metal.

Consumption is way down as a result of the business recession. In 1957 there were 8,544,000 lb of metal used, whereas the trend last year on an annual basis indicated a consumption of only 4,400,000 lb.

With the termination of some of the



The Idaho-Almaden mercury plant of Rare Metals Corporation of America near Weiser, Idaho

Cobalt

Virtually all domestic cobalt production is acquired by the GSA under contracts at prices either equal to or above the current quotation of $2.00 per lb. There is no duty on cobalt ores, concentrates or metal.

Domestic mine production in 1957 was 4,137,297 lb. an average of about 344,800 lb per month. The rate for the first eight months of last year was somewhat higher at about 380,000 lb per month. Imports in 1957 were 17,451,000 lb and for the first eight months of last year were 10,059,00 lb, equivalent to an annual rate of almost 15,000,000 lb.

Cobalt consumption in 1957 for all uses was 9,156,617 lb, and like other metals, its projected consumption of 5,500,000 lb for last year was on the decline. A recovery in the steel industry will create an increased de-

again the United States will be primarily dependent on foreign sources for this vital metal. The Cuban production due to start this year will be purchased by the GSA.

Calera Mining Co. requested the Office of Civil and Defense Mobilization under Section 8 of the Trade Agreements Extension Act of 1958 to determine if cobalt imports threaten to impair the national security.

Tungsten

Domestic tungsten production at an annual rate of 4,460,000 lb of metal last year declined substantially from the 1957 production of 8,032,000 lb. The decline was primarily a result of no Government purchases and heavy imports of low-cost concentrates. At the present time, there is only one primary producer in this country and the rest of the production comes as a

foreign contracts and also with the closing of some of the foreign mines on account of low prices, imports for consumption in 1958 averaged about 600,000 lb of metal per month, compared to 1,160,000 lb per month in 1957. Domestic purchases were at very low volume because industry stocks still were substantial.

Current quotes are in the range of $12.00 to $12.75 a short ton unit, excluding duty of $7.93 a short ton unit. Some sales earlier in 1958 were as high as $22.00 a unit for premium material. At the low point in September, 1958, some concentrates moved at $15.00 to $16.00 a short unit. The U. S. Tariff Commission published Investigation No. 33 of November, 1958, which is a study of the domestic and foreign tungsten industry.

Getchell Mines, Inc., Nevada Massachusetts Mining Co., Minerals Engi-

neering Co., Salmon Tungsten Co., and Tungsten Mining Corp. submitted requests to the Office of Civil and Defense Mobilization to determine under the provisions of Section 8 of the Trade Agreements Extension Act of 1958 if the imports of tungsten threaten to impair the national security.

Mercury

The rate of domestic production of mercury for the third quarter of 1958 was the best since 1944. Consequently the domestic output trend for 1958 was slightly ahead of that for 1957, being 27,320 flasks plus 1190 flasks of secondary mercury for the first nine months. Some 33,380 flasks with 5800 flasks of secondary metal were produced during 1957. Consumption in 1958 was 37,248 flasks for the first half of the year, compared to a total consumption in 1957 of 52,889 flasks. Imports for the first six months of 1958 were running considerably less, totaling 15,380 flasks, while in 1957 there were 45,449 flasks brought in.

According to one industry source, the 1957 figures and possibly those for 1958 indicate that the peace time consumption and production was the highest in 50 years. Public Law No. 733 provided for the GSA purchase of mercury and this program ended on December 31, 1958. As a result, year end prices dropped to the $220 to $224 range per flask.

In mid-year, mercury was available in large lots at $233 to $236 per flask, and reached a high of $239 to $243 per flask. The sale of European metal was slow, and with the GSA taking most of the domestic output, the domestic price was bound to reach the forementioned high level. Now, however, with the termination of the GSA purchase program, prices have skidded; and if technological improvements by the Spanish, Italian and Yugoslav producers work out, prices could very well recede below the $200 per flask figure. If so, the domestic mines may be out of business in 1959.

The U. S. Tariff Commission studied the domestic mercury industry and submitted a report to the U. S. Senate.

Fluorspar

Last year activities of the domestic fluorspar industry followed to a lesser degree the downward output of the steel and chemical industries. In this respect we can compare the 1957 crude mine production of 861,500 short tons with the six months reported production for 1958 of 369,500 tons equivalent to an annual rate of 739,000 short tons. Finished fluorspar shipped in 1957 from mines and mills was 328,872 short tons, and the trend as reported for 1958 calculates on an annual basis to be less at 270,000 short tons. Domestic consumption projected on an annual basis for 1958 is 491,000 short tons compared to the higher quantity in 1957 of 644,688 short tons.

Imports for consumption likewise show the wide spread over the two years as demonstrated in the foregoing figures. In 1957 there were 631,367 short tons imported, whereas the trend on an annual basis for 1958 indicates around 300,000 short tons.

Current domestic quotes are for acid grade concentrates, FOB Illinois, Kentucky or Colorado and other conditions, $50 to $55 per short ton. Ceramic grade is $45 to $48 and 72½ percent grade $37 to $41. Mexican metallurgical grade FOB border duty paid is $25 and $27 on barges Brownsville, Texas. European metallurgical grade, usual terms, is $34 to $35 c.i.f. U. S. ports with contract prices lower at $30 to $33. Acid grade 0.3 percent moisture maximum is $50 to $52 per short ton.

Fluorspar had been purchased under the provisions of Pubic Law 733 and this program closed at the end of 1958.

In October, 1958, the Independent Domestic Fluorspar Producers' Association filed with the Office of Civil and Defense Mobilization an application under Section 8 of the Trade Agreements Extension Act of 1958 for an investigation to determine if fluorspar imports threaten to impair the national security.

Chrome

The stockpiling program for critical minerals, which was instituted by the 79th Congress, recognized that a realistic approach to price was necessary to create incentive for domestic chromite production. However, the program provided at no time any continuity sufficient to induce more than a token capital investment on the part of the domestic miners. It is therefore all the more amazing to note that, in the face of the pessimism voiced in Washington in 1951, a record of production was made not only in the 10-yr program for Montana chromite of sub-metallurgical grade quality, but also in the states of California, Oregon, and Alaska in true metallurgical ores.

During the last 17 months of the program as much production of metallurgical ore was achieved as was delivered during the first 63 months. The impressive feat of proving reserves in but a few of the California mines which totaled over 113,000 tons unmined at the close of the program indicated the advantage of stimulating development of United States mineral sources.

The record domestic production (shipments) of chromite in 1957 was 166,157 short tons. Production last year was at an annual rate of about 150,000 short tons, a little behind 1957, due primarily to the termination of GSA purchases early in 1958.

Consumption by domestic industry in 1957 was 1,760,469 short tons. The indicated annual rate for last year was 1,030,000 short tons. Ore imports for 1957 amounted to a record 2,281,591 short tons, and the figures for last year indicate an annual rate of 1,450,000 short tons.

African metallurgical grade ore at year end was quoted in the range of $42 to $44 a short ton, and Turkish ore was at a nominal quote. These prices were down $2 to $4 a short ton from those of a few months ago.

It is of interest to record here that a few months ago one company arranged to acquire 80,000 long tons of chrome ore from Russia. This ore will come to the United States, either directly, or will be processed elsewhere and come to the U. S. in a form other than ore. The ferro alloys made will be supplied to one of the steel companies which in turn will export the equivalent value in steel products to the U.S.S.R. Since only a small portion of the chrome will be in the steel going back to the U.S.S.R., the effect will be to supplant a large share of chrome ore that otherwise might have been obtained from free-world sources.

Beryl

In 1957 domestic beryl production was 521 short tons, consumption was 4309 tons, and imports were 7290 tons. Domestic prices at that time were $529 a short ton with imported ores commanding $347 a short ton.

Preliminary statistics on the foregoing figures for 1958 indicate that domestic mines shipped virtually the same amount or 520 tons, consumption jumped to 6200 short tons, but imports dropped to 5500 short tons. The domestic price averaged the same at $529 a short ton and imported ore dropped slightly to $339 a short ton. Ores and concentrates enter the U. S. duty free, but the tariff on metal is 21 percent, the same figure on beryllium-copper master alloy, and 12.5 percent on beryllium compounds.

Hopes for increased interest in beryllium by the Air Force were quashed last July when the Government cut back contracts with the two major U. S. beryl companies to supply this mineral. Each contract to supply 100,000 lb of beryl metal billets per yr for five yr was reduced to 37,500 lb of ingot per yr for the 4½ yr period which began July 1, 1958. This meant that foreign miners cut production drastically. Domestic producers sell to the GSA under a program that expires June 30, 1962, or when deliveries total 4500 short tons, whichever occurs first.

Silver miners are faced with falling production and the persistence of a depressed price for their product, even though demand is rising. The reasons for this phenomenon are two-fold: (1) widespread demonitization of silver throughout the world, and (2) movement of Government-held stocks of silver into the market in competition with newly mined metal

Silver

By JOHN EDGAR

General Manager
Mining Division
Sunshine Mining Co.

BECAUSE it is the whitest of all metals, has the highest optical reflectivity and a perfect metallic luster, silver has been greatly prized in the arts and crafts since the beginning of history. These same qualities of beauty and utility plus its high value in small units are also responsible for its use as money throughout the greater part of history; that is, as a means of payment, a store of wealth and a standard of value.

Because of its other physical and chemical qualities, silver has found many other applications. It is the most malleable and ductile of all metals except gold and is the best known conductor of heat and electricity. A most important chemical property is the resistance of the pure metal to corrosion, and photography, with all its ramifications, is possible only because certain silver salts are sensitive to light.

Silver today remains of importance in arts and crafts and in addition, is of increasing utility in industrial applications not commonly associated with the arts and crafts, particularly in photographic film, in electronics, and most recently in electrical storage batteries. Silver-zinc batteries are a growing industrial use for silver. These batteries are as much as six times lighter and five times smaller than other batteries of similar capacity. In addition, the silver-zinc cell discharges at a constant voltage level and is ideally suited for use in jet aircraft, guided missiles, portable television cameras, and a wide variety of communications, instrumentation, and photographic equipment. In most areas, and among vast populations, of the world, notably in Asia, Africa, the Middle East, and Latin America, silver continues to be of great importance as a store of wealth.

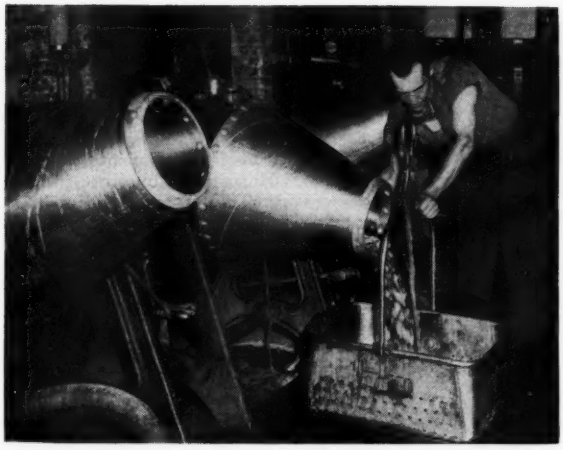
"The baby born with the silver spoon . . ." calls attention to the importance of silver in the arts and crafts. From a yearly consumption of 20,000,000 oz near the turn of this century, the arts and crafts have increased consumption to an average of about 100,000,000 oz of silver annually

A Paradox—Demand Rising But Production Down

But, despite an increased domestic demand for the metal, and contrary to the case with most of the U. S. mining and mineral industry, silver mining has for a long time been a shrinking activity. While total metallic ore production has increased threefold since the turn of the century, silver production has fallen by a third. At the beginning of the century, consumption of silver in the arts and crafts ran around 20,000,000 oz annually, while demand for silver for subsidiary coinage consumed around 3,000,000 oz yearly. For the past several years the arts and crafts and increasing industrial uses have consumed an average of approximately 100,000,000 oz annually, and another 37,000,000 oz, or about the amount of domestic production, has been used for subsidiary coinage.

The immediate cause of declining silver production is found in the price received for silver in relation to the cost of producing silver. Mining costs, moving with the general price level, have made unprofitable the search for, and the development of ore bodies, and have forced the closing of many existing mines.

The plight of the silver mining industry, with falling production and the persistence of a depressed price in the face of a rising demand, is due to the wide-spread demonetization of silver in the world at large, and the



Some 37,000,000 oz of "free silver"—an amount about equal to U. S. production —is used each year by the Treasury for subsidiary coinage

movement of Government-held stocks of silver into the market in competition with newly mined silver. Market analysts generally agree that the heaviness of the silver market is due to the overhang of U. S. Treasury stocks and the uncertainty as to U. S. policy in regard to silver.

Production of silver in the United States in 1958 is estimated at 34,000,000 oz compared with 38,700,000 oz in 1957. Total estimated world production for 1958 is 204,700,000 oz in pared with 199,000,000 oz for 1957.

World consumption of silver in the arts and industries is estimated at 187,400,000 oz, compared with 210,000,000 oz in 1957. The arts and industries in the United States consumed 85,000,000 oz, a decline of 10,000,000 oz from 1957.

World consumption of silver for coinage purposes totaled 63,100,000 oz in 1958 compared with 79,200,000 oz in 1957. United States coinage requirements amounted to 36,200,000 oz in 1958 compared with 51,400,000 in 1957. U. S. coinage requirements, however, are met by withdrawals from Treasury stocks of unpledged silver bullion and have no impact on the market. U. S. Treasury "free bullion" stocks on December 31, 1958, are estimated at 202,200,000 oz compared to 127,400,000 oz on December 31, 1957.

Metal Backing Stabilizes Paper Money

U. S. monetary policy in regard to silver is governed by the Silver Purchase Act of 1934 which declares the policy of the government to be the acquisition of silver for the monetary stock until such stock represents one-fourth that of gold. At the present time, there are in circulation in excess of $2 billion in the form of silver certificates against which a reserve of 100 percent in silver is maintained, and it is worth noting that these certificates constitute the only paper money in the world today that is fully backed by the metal which it purports to represent. In addition, the U. S. silver certificate is the only money anywhere that has survived two world cataclysms, is the only money that has never been in default, is the only money that has continued redeemable at its tenure at all times.

It is obvious that U. S. monetary policy stems from the political and economic sense of the American people, their innate suspicion of bank money, and a latent hunger for a form of paper money that can be redeemed at its tenure.

"Free Silver" Puts Ceiling on World Market Price

When a silver producer tenders 1000 oz of newly mined domestic silver to the Treasury, he receives $1.29 an oz for 70 percent of his silver, or a total of $905.00 in silver dollars or silver certificates which are of the nature of warehouse receipts for the silver which the Treasury keeps in its vaults as depository trustee, the title of which rests with U. S. citizens and others who may be holders of the certificates.

The remaining 30 percent, or 300 oz out of the 1000 ounces that the producer sells to the Treasury, is "free silver" and can be used by the Treasury for subsidiary coinage at a profit of $385.00, or since the act of July 31, 1946, may be sold by the Secretary of the Treasury at such prices as in his discretion he might determine, but not less than 90½ cents per oz f.o.b. San Francisco. This fund of "free silver" in the U. S. Treasury which overhangs the world market has resulted in placing a very effective ceiling on the world price for silver. Domestic producers feel that the intent of the 1946 act would have been better served if the Secretary of the Treasury had used his discretionary authority to maintain a substantial differential in the Treasury selling price over the open market price.

The "free silver" or disposable silver in the Treasury general fund stood at less than 100,000,000 oz at the close of the last fiscal year. Treasury need for silver for subsidiary coinage is currently taking more silver than comes into the fund from regular sources of supply. The effect of continued heavy Treasury sales to industry and the arts added to coinage requirements, will soon exhaust the reserves. The Treasury will then be compelled to go into the market for the added quantities needed with the probable consequence of higher costs to the Treasury. Prudent fiscal management of the public funds would therefore indicate that Treasury sales of silver be discontinued in order to conserve silver for Treasury's own needs.

Silver Miners Paid With Their Own Product

There was no new silver legislation in 1958. The usual bills calling for repeal of all silver purchase legislation were introduced in the House and Senate, but were not reported out of committee. Undoubtedly there will be new bills introduced in this session of Congress.

In view of such efforts, with the attendant propaganda and misinformation, it is timely to emphasize that no taxes are levied by Congress to provide funds for the purchase of domestically-produced silver. The producer is, in effect, paid with silver dollars coined from a portion of the silver delivered by him to the Treasury. At present his payment consists of 70 per cent of the silver delivered by him and he can take it in silver dollars or in silver certificates which are exchangeable on demand for silver dollars.

Over the years, the seigniorage retained by the Treasury has been progressively reduced until it now stands at 30 percent. The silver producers feel that this policy of progressive reduction should be continued until seigniorage has been completely eliminated.

John Edgar has high qualifications to write this year's review on silver. His entire professional career, which began after graduation from University of Washington with a degree in mining engineering, has been with Sunshine Mining Co., one of the world's major silver producers. Edgar started with the company as an engineering assistant, and after serving in several positions, was made general manager of the Mining Division in 1957.

Rare Metals

Much of the glamour has faded, but a healthy interest remains in the "new" metals which offer great promise because of their unique physical characteristics

By M. H. KLINE
Vice President
Rare Metals Corporation of America

IN 1950 titanium was referred to as the "Wonder Metal," and zirconium was called the "Cinderella Metal." Various Government agencies were making every effort to locate uranium and thorium deposits and encouraging private industry, through various incentive programs, to join in the search. The U.S.G.S., the U.S.B.M., the A.E.C., and some segments of the mining industry were diligently looking for selenium, the rare earths, beryllium, columbium, tantalum, and other metals then considered rare. Dozens of research laboratories were engaged in developing processes to extract these metals from their ores, or were modifying older processes to make them more efficient and economical. Although there still remains a healthy interest in these metals, much of the glamour has faded, and the work being done on them in 1958 is at a more leisurely pace. During this period much has been accomplished toward the economic production of many of these metals, but by no means is the job finished; there still remains much to be done.

Present Status of Rare Metals Outlined

The term "rare metals" has had different meanings at different times and in different places. To the Stone Age man all metals were rare. Today some of the metals, such as uranium, zirconium, and titanium, which were classified as rare in 1950, are being produced in excess of consumption in the United States. In other countries these metals are still in the rare category. Possibly by 1965 in the United States only the trans-uranic elements may be truly rare. For the purpose of this paper, however, let's review what has happened to, and the present status of, some of those metals classified as rare during the period 1950-58.

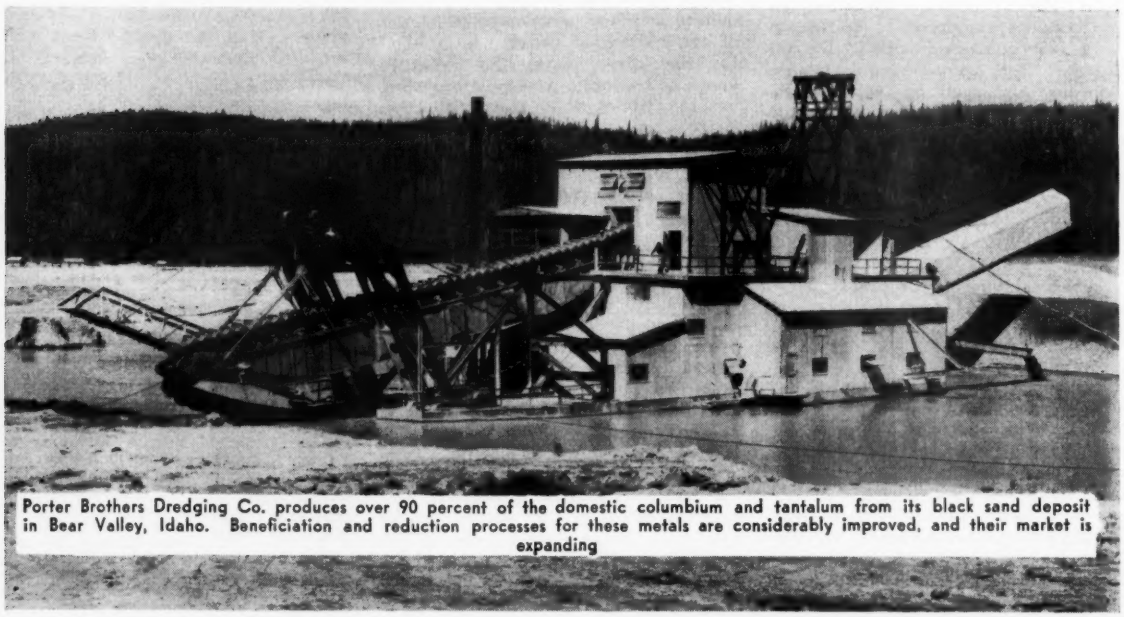
Beryllium: There has been a reasonable increase in the production of beryllium during this eight-year period. However, there has been no discovery of a major commercial deposit of beryl in the United States. Practically all of the raw material still has to be imported. No very satisfactory beneficiation process to recover beryl has been devised. The demand for beryllium continues to be good.

Columbium-Tantalum: Our supply of these metals is still largely from foreign sources, although one major operator in Idaho is producing substantial quantities of columbium. Beneficiation and reduction processes for these metals have improved considerably during the period under consideration. Important new reserves of columbium have been found in the pyrochlore deposits of Africa, Sweden, Canada, and Brazil. Considerable work has been done on the processing of these ores, and with an adequate market they could be economically exploited. Unfortunately, the picture for tantalum is not so bright, and the raw materials for this metal continue to be in short supply. The market for both these metals is expanding.

Gallium-Germanium-Selenium: No new major deposits of these metals have been discovered. They are produced as byproducts from other metallurgical operations, and no major changes in technology have been made. Production and consumption seem to be more or less in balance.

The Rare Earths: Several large deposits of this family of metals have been discovered since 1950, and domestic production was maintained from three large operations for several years. However, competition from foreign sources has closed down all of these producers. Technical advances on processes have been great, and all of these metals could be produced in commercial quantities if there were an adequate demand for them. Government contracts for the purchase of thorium have resulted in a surplus stockpile of the rare-earth metals, as they are a byproduct from thorium production.

Titanium-Zirconium-Hafnium: Adequate reserves of all these metals exist in various areas in the United States. Modifications of the Kroll process and some new methods have been devised to produce these metals. However, a satisfactory continuous process for reduction to metal is still



Porter Brothers Dredging Co. produces over 90 percent of the domestic columbium and tantalum from its black sand deposit in Bear Valley, Idaho. Beneficiation and reduction processes for these metals are considerably improved, and their market is expanding

highly desirable and would probably reduce costs for these three metals. At present, production is probably in excess of consumption. Nevertheless, the future requirements for these three metals will ultimately be large.

Thorium-Uranium: Even the most optimistic have been surprised at the rapid discovery of reserves for both these metals in the United States and Canada. Uranium ore production in the United States totaled about 2,500,000 dry tons for the first six months of 1958 as compared to approximately 2,000,000 dry tons during the last six months of 1957. Great advances in the beneficiation and reduction of these metals have been accomplished in the last five years. However, it is doubtful that progress in the future will be so rapid. At present, production of both these metals is undoubtedly in excess of immediate requirements. In the near future it appears that uranium will be in much greater demand than is now anticipated. Thorium will ultimately have to supplement uranium as an atomic fuel, but certainly this is a longer-range prediction. In any case, for the present, uranium is the healthiest segment in the mining industry, and much credit for this situation must be given to the Atomic Energy Commission for the capable control they have exercised over these operations.

While all the so-called rare metals have not been covered, at least the important ones have been considered.

New Metals Face Marketing Problems

Looking into the future, there are inherent marketing problems that have a few general characteristics but many more individual ones. Alternating periods of surpluses and shortages characterize the production of any new metal, as well as in some of the older ones, and naturally these fluctuations are disastrous to the operator. Anyone acquainted with the early aluminum market, the later magnesium market, and the most recent titanium and zirconium markets will have splendid examples of what the author means. When a metal is first produced in quantity, its uses are limited and fabricators are reluctant to change established industrial patterns or stand the expense necessary to develop markets for the sale of the new commodity which almost immediately results in a surplus of the metal.

Mitchell H. Kline was graduated from the University of Utah in 1926. The following year he worked as a junior engineer for Anaconda Copper Mining Co. During the years 1928 to 1939 Kline worked in Bolivia for Guggenheim Brothers Corp., and Aramayo Mines Company of Bolivia; and served in Chile as mine foreman for the Braden Copper Co.

After returning to the States and attending Massachusetts Institute of Technology, Kline undertook several responsible Government positions culminating with his promotion to chief of the Rare and Precious Metals Branch, Minerals Division, U. S. Bureau of Mines. In 1954, he resigned from the USBM and went to Salt Lake City to staff and direct operations for the Rare Metals Corporation of America, a newly formed subsidiary of El Paso Natural Gas Co. He is presently a vice president for the company and is directly in charge of all operations.

On the other hand, when there is an inadequate supply of material, and good examples of this are columbium, beryllium, and tantalum, manufacturers do not like to be dependent upon such a limited source of supply and will invariably prefer available substitutes.

Then, too, there is always the hazard of imports, and this is especially disastrous for domestic production. We have a good example of this in the monazite and rare-earth industry. All the domestic mine producers are now out of business.

However, in an atomic and jet-propulsion age, rare metals are bound to become more and more essential.

In the President's Materials Policy Report, the electric power demand estimated for 1975 is something like 1400 billion kwh, tripling the 1950 demand of 389 billion. Certainly a large part of this power requirement will have to be met by atomic reactors fueled with uranium and thorium. Fusion reactors are still many years away. Atomic-powered ships, rockets, and probably later planes will also require additional reactors. The construction of all these will demand not only an increase in the production of uranium, but also other metals such as zirconium, hafnium, beryllium, etc.

The successful attainment of supersonic speeds will depend on the increased production of titanium, columbium, and tantalum required to withstand the high temperatures encountered. The expanding use of electronic equipment in planes and rockets where weight is an important factor will demand more semi-conductors such as germanium and selenium.

Unusual Physical Properties Offer Future Promise

What part the rare earths may play in the future is now uncertain, largely because these metals and their characteristics are not well known, but surely most of them are destined to play an important role in future metallurgy. For example, from the relatively meager knowledge available about these elements, we do know that gadolinium has some very unusual magnetic properties. At room temperature it is a magnet. If heated by so little as body temperature, it no longer displays this property. A small particle of thulium, when activated by radiation and placed in a shield of lead no bigger than a pool ball, can become the equivalent of a heavy and bulky X-ray machine. Such an apparatus could be easily carried under the most extreme conditions onto the battlefield or into inaccessible places.

To summarize, the future for rare metals is great, important strides have been made in the past decade, and a bright and intriguing future lies ahead. These metals will not dominate the industry tomorrow, if ever; but nevertheless, the producers of rare metals can share with the rest of the mining industry the responsibility of making this world a better place in which to live.

MOLYBDENUM

(Continued from page 108)

lybdenum metal for applications where its adoption has been hampered by size and processing limitations. Notable during the year was the production of forged molybdenum-metal valves for high-temperature sulfuric-acid service where even tantalum had not been satisfactory.

1959 and After

Predictions for 1959 foresee a moderate improvement in production and consumption of molybdenum. By-product producers increased their rate of production towards the end of 1958; if this continues, the proportion of by-product molybdenum should be higher in 1959 than in 1958. Demand at the mines will also be affected if the British Board of Trade goes ahead with its announced intention to release a little over a million pounds of molybdenum in concentrate from its strategic stockpile.

It is expected that molybdenum consumption in the United States will increase along with the national economy. Steel production and therefore molybdenum consumption in this industry may improve even more rapidly than the economy as a whole if fabricating plants begin to rebuild their run-down inventory. Consumption outside the United States may recover more slowly because the drop in business activity occurred later abroad than here.

The longer-term outlook is encouraging in all countries. Chemical, lubricant and other non-metallurgical applications should take more molybdenum, while the role of molybdenum metal is certain to gain in significance. New grades of molybdenum-containing iron and steel designed to meet the ever severer requirements of industry should account for increasing amounts of molybdenum.

Gold

By REID TAYLOR
Mitchell, Hutchins & Co.
Chicago, Illinois

Reid Taylor is a stockbroker not a miner, nor does he pretend to be an economist. What he has learned about gold has come through study, assimilating and rejecting, in an honest attempt to bring a little old fashioned common sense into the picture.

Who's afraid of gold —and why?

WHY isn't it just as important that the Government be required to set aside reserves of gold to make the money good as it is important for a bank to set aside reserves to meet the demands of its depositors?

Gold and money is a subject that almost everyone seems to shy away from. Is it any wonder that the man on the street is confused when those to whom he would naturally look for guidance are either confused, or issue completely misleading statements?

Confusion Planted in Men's Minds

For instance, the spokesman for an organization which purports to be for sound money seems to fear a free market for gold as a first step to determine the true value of our dollar. By insisting that we must value gold in terms of paper dollars, he is in effect saying that he still considers the degraded paper dollar to be the standard of value instead of gold.

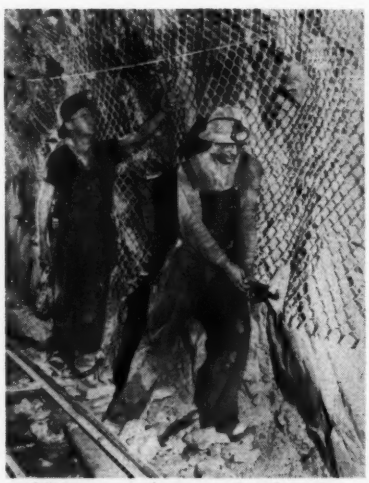
One of the leading banks of our country, several years ago, extolled the gold standard in one bulletin and then in a succeeding bulletin completely reversed its stand, spending 11 pages trying to justify the paper dollar with its hairspring tie to gold as the standard of value. All the usual rubber stamp arguments were trotted out: only the speculators and gold miners would profit by a higher price for gold; it would be inflationary; Russia would unload on us, and so on. No mention was made of getting back to gold to establish the true value of our money, stabilize our economy and stop inflation once and for all. No mention was made of the stimulus to international and multilateral world trade which would come about if we would lead the world back to gold.

Possibly the planting of this confusion in men's minds was not by accident. You will remember the philosophy as stated and admitted by one of the planners some years back, "Spend and spend, tax and tax, elect and elect."

The schemers who set out to change our form of government recognized that in order to fasten their grip on this great Nation they must devise a method to spend the past accumulated wealth of the American people without their being too conscious of what was going on. In this way there would be an illusion of great prosperity until their purposes were accomplished. Gold must be completely eliminated from the scene. If free to circulate, its rise would bring home to the man on the street the fact that what his Government spent was really being slyly deducted not only from the paper dollars he earns, but far more tragically, stolen from the savings he might have accumulated for his old age and those who live after him.

The curtain raising performance was one which no man will ever forget; the severing of the tie between the dollar and gold in 1933; the seizure of all gold; the prohibition of all trading in gold, and finally after the Government had a virtual corner on gold, the bidding up of the price with the avowed and well advertised purpose of devaluing the dollar to raise the price structure. This was calculated to confuse the entire gold issue in men's minds from that day to this. There has never been any real tie to gold even at $35 to the ounce.

As the years passed we grew more and more accustomed to this idea that the dollar was worth only 59 percent of its former value, or in other words that an ounce of gold was worth $35 instead of $20.67, as formerly, even though you couldn't prove it because you were not allowed to redeem your dollars in gold at that price or any other price.



Mining costs have continued to increase, but the price of gold remains the same

We also became more accustomed to bigger and bigger government, higher and higher taxes, bigger and bigger budgets, a WPA that gradually grew into a world WPA, war and more war; hot or cold it makes little difference, the spending goes up and up in peace-time as well as in war-time. A Government debt approaching 300 billion dollars, a money volume of almost that much based on that debt, an overall public and private debt approaching a trillion. All this means nothing to the man on the street. A dollar is a dollar even though it will buy only a fraction of what it would formerly. But there is one thing that he is sure of in his mind. The price of gold must not be changed again. He will not try to think through simple processes. All he can remember is that initial curtain raising performance of 1933 and 1934. He is told by bankers, by economists, by investment services, by the above mentioned sound money crusaders, and in practically everything he reads, that it must not happen again because it would be inflationary.

The act in itself was not inflationary except as it aroused the fear of the future intentions of our authorities. The Government had to all intents and purposes cornered the gold market and there was no actual tie between the dollar and gold, so its influence on the price structure was more psychological than real, as some speculators found out to their sorrow. But all that was anticipated by that abortive thrust in our markets has since become a reality; not through raising the price of gold but through the carrying out of that plan to "spend and spend, tax and tax, elect and elect." Do you remember how shocked we were under WPA when it got aired around that there was a plan under foot for a world WPA? No one would believe it.

No, certainly our authorities would not be foolish enough to pull such an act as raising the price of gold again arbitrarily. That act served its purpose at the time and is still serving that purpose, and sadly so, because it is throwing the American people off their guard and is blinding everyone to realities.

Foreigners Withdrawing Gold

Up to now we have been able to maintain the fiction of the $35 price, or in other words we have been able to maintain the apparent value of our dollar in the world market. This, of course, has been due to our position of dominance, our ownership of over

half the world's monetary stock of gold, to the weakness of foreign currencies relative to our own, to our fantastic give-away and to our great productive capacity.

With about 6 percent of the world's population we have accounted for one-half of the world's total output. It is plain enough that any foreign nation with dollar credits has, up until now, been interested in acquiring steel and machine tools—not gold. But now the scales are weighted the other way. We are being priced out of the world market. Thanks to us, foreign nations have increased their own productive capacities enormously. Their reason for wanting our products is evaporating day by day. They want gold, instead of a depreciating dollar.

Our daily papers carry reports of the U. S. Treasury and the condition of the Federal Reserve System for every one to read. Very few people even bother to look at these figures. Yet in such reports, uninteresting in themselves, if followed week after week, there are unfolded trends which may be tomorrow's headlines and the concern of everyone.

Such is the case with the continual withdrawal of gold by foreigners week after week for the past nine months. This occurrence is played down by our officials, as is the persistent decline in Government bonds. The two, no doubt, have a very real connection.

Present Policies Might Be Helping Russia

Philip Cortney recently made the statement that what we should fear is that Russia will buy our gold at the present low price rather than that she will sell us gold if the price is raised.

This is food for thought. Possibly she would have been wiser to have expanded and developed her farms so that she could feed her people properly. But right or wrong, she chose the course of intense industrialization. So now, in order to live, she must unload her output on the outside world. This much we know is an established fact. However, the idea of the build-up of an enormous gold production within her borders is more questionable. Try to trace the source of her production figures and you get nowhere. Little if any more than what she stole from Spain in the 1930's has ever actually appeared in the world market.

Now let's take one more logical step along this line of thought. Doesn't the smart trader in any commodity talk prices down when he wants to buy? Doesn't he talk the price up if he wants to sell? If Russia is as smart as we give her credit for being and she wants to acquire gold, what would she do? Wouldn't she build up this idea of her big gold production and her big stock of gold as a threat overhanging the market if we should raise the price? Isn't this logical? The author believes she is doing just this, expecting to make a killing at our expense on the gold she can take down. Any profit or loss she might take by flooding the world with her goods would pale into insignificance by comparison.

Furthermore, all this would tie in with the Marxian theory to debauch our currency and destroy our economy. She must know that by denuding us of our gold this process can be hastened materially. Her silence is her "big stick" to warp our thinking. Her agents are fast at work night and day to spread her gospel of confusion over our land. One way or another they put words into the mouths of our officials, our bankers, our economists, our unwilling-to-think public.

Let's never repeat or allow to be repeated in our presence without challenge that: "A higher price for gold would be inflationary," or that "A higher price for gold would help Russia."

Gold has never lost a battle with inconvertible paper money. It only seems to go up in price because inconvertible paper money never fails to go down. It is understandable that a dictatorial and profligate government should fear the verdict of a free gold market. Such a government fears a free gold market because it is the logical first step to restore redeemable money. Wherever you find money redeemable in gold you find a sane and responsible government, and an economy that is sound—not one built on the shifting sands of inflation.

It is more difficult to understand how a group of men who are crusading for the gold standard can be afraid of that standard, and prefer to go along with the vagaries of an arbitrary value set on gold which has permitted such an inflationary binge as we have experienced over the last 25 years.

However, the world market for gold is far too broad for any one country to control for long. And in spite of what some men think the price should be, it is becoming more apparent every day that Gresham's law, thwarted for so long within this country, is about to break those barriers. Bad money will drive good money out of circulation, if allowed, or out of the country, and this is being allowed.

Are our authorities big enough to recognize that this means a higher price for gold or will they continue to confiscate the country's accumulated wealth until our stock of gold dwindles and gold brings a fantastic price in terms of our paper money? Such a chaotic condition of affairs may well mean that Russia's ideology will have won out without the firing of one of those atomic war heads which we are worrying so much about.

PHOSPHATE

(Continued from page 102)

Monsanto, Victor and Shea Chemical (now Hooker) use about 75 percent of all Tennessee production as electric furnace feed for the production of elemental phosphorus. A small tonnage is shipped to TVA's electric furnace at Florence, Ala.

The remaining 25 per cent of Tennessee rock goes into agricultural use, either as ground rock for direct application to the soil, or for the manufacture of superphosphate. Armour and Virginia-Carolina Chemical both manufacture superphosphate; both also operate their own mines and washers.

Boyle, Highland, Ruhm and Virginia-Carolina Chemical all produce ground rock for direct application. Boyle, Highland and Virginia-Carolina have their own production facilities. Ruhm withdrew from production during the year and is now a marketing agency only.

International Minerals & Chemicals closed down almost all its operations during 1958. Only a small operation is carried on at Wales—washing and grinding.

Hooker Electrochemical acquired Shea Chemical during the year and now operates its furnaces. As yet, this company purchases all its furnace feed rock from contractors.

In general, the three U. S. fields held their same relative position in 1958. Florida's rock was highest grade, averaging over 72 per cent tricalcium phosphate. Over 70 percent of all Florida rock went into agricultural uses (43 per cent went into ordinary superphosphate, and 19 per cent into triple superphosphate). Almost 23 per cent of Florida rock was exported; only six per cent went into domestic industrial use.

Western States' rock averaged only about 60 per cent tricalcium phosphate. The uses for Western rock reflect the lower grade and the cheapness of electric power in that area. Over 58 per cent of Western rock went into industrial uses, mostly electric furnaces. Not quite 24 per cent went into agriculture, and almost 18 per cent was exported to Canada.

Tennessee's rock, at 57 per cent tricalcium phosphate, was still lower grade than for the Western states. Again, because of low grade and the attractive electric power rates, over 75 per cent of Tennessee rock went into electric furnaces. Less than 25 per cent went into agricultural uses (either as direct application ground rock, or for ordinary superphosphate).

Some exploratory activity continued in North Carolina, but there were no known plans for starting production from this field.

Sales of Coal Mine Equipment

By W. H. YOUNG and R. L. ANDERSON
Chief, Bituminous Coal and Lignite Section,
and Supervisory Commodity-Industry Analyst
U. S. Bureau of Mines

The past year saw almost 90 percent of the total output of bituminous coal and lignite mechanically loaded at underground mines, loaded by power shovels at strip mines, or mined by augers along highwalls in strip mines. Significantly, the percentage of total output mechanically cleaned increased in 1958 from 1957

SHIPMENTS of mechanical loading equipment for underground use in coal mines in the United States, in terms of capacity, decreased 38 percent in 1958 from 1957. The capacity of mechanical cleaning equipment sold for use at bituminous coal mines was 22 percent less in 1958 than in 1957. Shipments of all major types of mechanical loading and conveying equipment decreased in 1958 from 1957.

This survey was made possible by the cooperation of all known manufacturers of mechanical cleaning equipment for bituminous coal mines and of mechanical loading and supplementary haulage equipment and coal-recovery augers for use in all coal mines in the United States. Information from various trade journals also was used.

Sales of mechanical loading units, coal-recovery augers, and supplementary haulage equipment in 1958, as in previous years, represent shipments during the year. Of the total capacity of mechanical cleaning equipment sold in 1958, 34 percent was placed in operation during that year; the remainder (66 percent) will be installed later.

Table I.—Bituminous coal and lignite production, by methods of mining and by mechanical cleaning, in the United States, 1956-58, inclusive

	1956		1957		1958[1]	
	Thousand net tons	Percent of total	Thousand net tons	Percent of total	Thousand net tons	Percent of total
Hand-loaded underground	58,372	11.6	54,912	11.1	42,000	10.6
Mechanically loaded underground	307,402	61.4	305,737	62.1	239,000	60.2
Mined at auger mines	8,045	1.6	7,946	1.6	7,000	1.8
Mined by stripping	127,055	25.4	124,109	25.2	109,000	27.4
Total production	500,874	100.0	492,704	100.0	397,000	100.0
Mechanically cleaned	292,365	58.4	304,027	61.7	265,000	66.8

[1] *Preliminary.*

Table II. Underground bituminous coal and lignite production, by methods of loading, 1956-58, inclusive

	1956		1957		1958[1]	
	Thousand net tons	Percent of total	Thousand net tons	Percent of total	Thousand net tons	Percent of total
Mobile loading machines:						
Loading direct into mine cars	35,428	9.7	24,797	6.9	[2]	[2]
Loading onto conveyors	14,069	3.8	14,419	4.0	[2]	[2]
Loading into shuttle cars	198,844	54.3	197,506	54.8	[2]	[2]
Continuous mining machines	39,907	10.9	53,783	14.9	[2]	[2]
Scrapers	156	....	81	....	[2]	[2]
Conveyors equipped with Duckbills or other self-loading heads	3,727	1.0	2,699	.7	[2]	[2]
Hand-loaded conveyors	15,271	4.3	12,452	3.5	[2]	[2]
Total mechanically loaded	307,402	84.0	305,737	84.8	239,000	85.1
Hand-loaded into mine cars	58,372	16.0	54,912	15.2	42,000	14.9
Total underground production	365,774	100.0	360,649	100.0	281,000	100.0

[1] *Preliminary.*
[2] *Included with "Total mechanically loaded."*

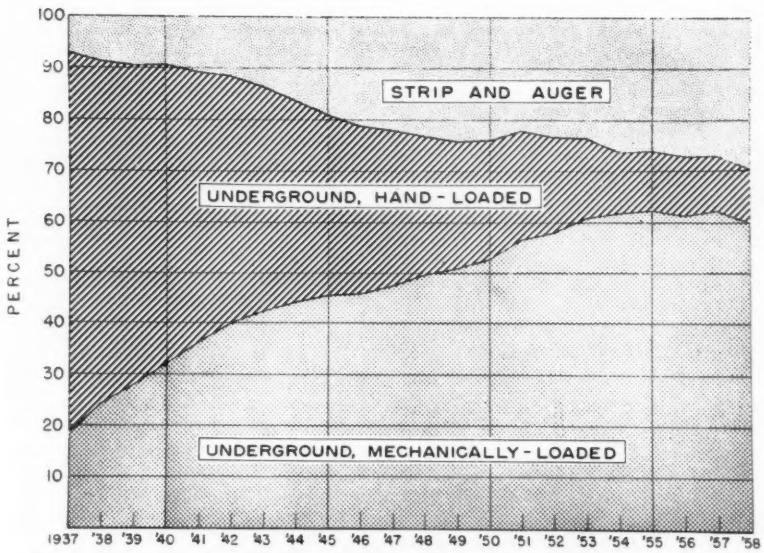


Fig. 1. Percentage of total production of bituminous coal and lignite in the United States, 1937-58 by type of mining and loading

When it comes to coal mining statistics, W. H. Young and R. L. Anderson probably know as much as anybody in the industry. We are again proud to present their annual review of equipment sales.

Dr. Young first joined the U. S. Bureau of Mines as an economist in the Coal Economics Division. Since 1944 he has served as chief of the Bituminous Coal Section.

W. H. Young

R. L. Anderson

After several years experience with a firm of consulting mining engineers, R. L. Anderson joined the Government in 1934. Since that time he has been employed by various agencies having to do with coal and at the present time is a commodity-industry analyst with the Bureau.

Mechanical Loading and Mining

Bituminous coal and lignite mechanically loaded in underground mines decreased from 306,000,000 tons in 1957 to an estimated 239,000,000 tons in 1958. Production at strip mines decreased from 124,000,000 tons to an estimated 109,000,000 tons, and auger mine production decreased from 8,000,000 to 7,000,000 tons during the same period.

Table I shows data on bituminous coal and lignite production, by methods of mining, and mechanical cleaning for 1956-58, inclusive. The percentage of total production of bituminous coal and lignite in the United States, 1937-58, by type of mining and loading in shown on figure 1. The percentage of total output mechanically cleaned increased in 1958 over 1957. During 1958 almost 90 percent of the total output was mechanically loaded at underground mines, loaded by power shovels at strip mines, or mined by augers along highwalls in strip mines.

Underground production of bituminous coal and lignite, by methods of loading, is listed in table II. It is estimated that the percentage of underground production mechanically loaded in 1958 was higher than the previous year.

Auger Mining. Augers are used for coal recovery along highwalls in strip mines and on bench operations where coal cannot be economically mined by stripping. Separate data on the number of augers in use and the tonnage produced by auger mining were first collected for 1952.

Reports from four manufacturers of coal-recovery augers show that 45 augers were shipped in 1958 compared with 55 in 1957, a decrease of 18 percent. All augers shipped in 1958 were for surface use, except one shipped to Tennessee and the three shipped to Pennsylvania anthracite mines for underground use. Table III shows coal-recovery auger shipments in 1954-58, and table V the number in use in 1957 and shipments in 1958, by States.

Types of units sold. Table III lists the units of mechanical loading and mining equipment shipped for use at coal mines in the United States, 1954-58, inclusive. Shipments of practically all equipment decreased in 1958 from 1957. However, one scraper loader was shipped to a bituminous coal mine, the first to be shipped in four years, and three augers were shipped for underground use at Pennsylvania anthracite mines in comparison with two in the previous year.

Exports of underground mechanical-loading equipment, in terms of

Table III. Units of mechanical loading and mining equipment sold for use in coal mines, as reported by manufacturers, 1954-58, inclusive

Type of equipment	1954	1955	1956	1957	1958	Change from 1957 (percent)
Bituminous coal and lignite mines:						
Mobile loading machines	92	120	239	209	97	− 53.6
Continuous-mining machines	101	109	154	168	107	− 36.3
Coal-recovery augers	55	65	89	53	42	− 20.8
Scrapers[1]	5	...	...	...	1	....
Shuttle cars	242	348	560	488	181	− 62.9
Gathering and haulage conveyors[2]	19	78	137	172	97	− 43.6
Room or transfer conveyors[3]	61	143	232	159	92	− 42.1
Bridge conveyors	(4)	(4)	128	96	66	− 31.2
Anthracite mines (Pennsylvania):						
Mobile loading machines	17	1	...	1	...	−100.0
Continuous mining machines	1	...	...	1	...	−100.0
Coal-recovery augers	...	1	...	2	3	+ 50.0
Scrapers[1]	...	2	...	...	...	....
Shuttle cars	14	8	2	2	...	−100.0
Gathering and haulage conveyors[2]	...	3	...	2	...	−100.0
Room or transfer conveyors[3]	24	7	19	45	21	− 53.3
Bridge conveyors	(4)	(4)	...	1	...	−100.0
Number of manufacturers reporting	23	22	22	21	18	....

[1] *Reported as scrapers or scraper haulers and hoists.*

[2] *Includes all haulage conveyors with a capacity over 500 ft, except main slope conveyors.*

[3] *Includes all haulage conveyors with a capacity of 100 to 500 ft, except main slope conveyors.*

[4] *Not available.*

capacity, amounted to 15 percent of the shipments to mines in the United States in both years 1957 and 1958.

Types of mechanical-loading equipment sold compared with units in use. Table IV shows the trend in demand for various types of mechanical loading equipment. Continuous mining machines were first used in 1948; however, the number in use was not shown separately until 1952. The number in use has increased every year from 1952 to 1957. Shipments of continuous mining machines in 1958 were 17 percent of the number in use in 1957. Mobile loading machine shipments in 1958 were three percent of the number in use in 1957.

Table V shows the number of mechanical loading units and coal-recovery augers shipped to various States in 1958 compared with the number in use in 1957, as reported by mine operators. Sales of room conveyors as listed in table V are not exactly comparable with the number of room conveyors in use. To avoid duplication in tonnage mechanically loaded, each mine operator was instructed to report "hand-loaded" and "self-loading" conveyor tonnage only; therefore, conveyors loaded by mobile loading machines and continuous mining machines are not included with "Room conveyors in use in 1957." Shipments of coal-recovery augers to bituminous coal mines in 1958 were 14 percent of the total number in use in 1957.

Haulage Equipment

Bridge conveyors. Sales of bridge conveyors decreased from 97 in 1957 to 66 in 1958 or 32 percent. Shipments by States are listed on table VI.

Shuttle cars. Sales of shuttle cars decreased from 490 in 1957 to 181 in 1958. Details of shipments to various States in 1957 and 1958 are given in table VI.

Gathering and haulage conveyors. (Formerly listed as "mother" conveyors.) For the purpose of this study "Gathering and haulage conveyors" include sectional, extensible, power-driven conveyor units that can handle over 500 ft of conveyor. Main slope conveyors are excluded. Table III lists sales for 1954-58, inclusive, and table VI shows shipments by States in 1957 and 1958.

Mechanical Cleaning

Reports from 21 manufacturers of bituminous coal cleaning equipment show that the total capacity of 1958 sales was 10,350 net tons of clean coal per hour compared with 13,225 tons of capacity sold in 1957, a decrease of 22 percent. Sales in 1958, by type of equipment, in terms of capacity, show that jigs ranked first, followed by dense medium and wet tables. The capacity of all types of equipment sold in 1958 for cleaning bituminous coal by wet methods was equivalent to

Table IV. Sales of mechanical loading equipment in 1958 compared with machines in use in preceding years

	Number of machines in use, as reported by mine operators					Number of machines sold as reported by manufacturers in
	1953	1954	1955	1956	1957	1958
Bituminous coal and lignite mines:						
Mobile loading machines	3,985	4,314	3,819	3,854	3,755	97
Continuous mining machines	219	325	385	510	614	107
Scrapers	29	48	23	35	14	1
Conveyors equipped with Duckbills or other self-loading heads	849	633	487	437	361	(1)
Hand-loaded room conveyors, number of units	2,994	2,162	1,925	1,819	1,528	92
Anthracite mines (Pennsylvania):						
Mobile loading machines	39	68	79	80	66	...
Continuous mining machines	...	...	...	...	...	...
Scrapers	489	359	279	303	295	...
Hand-loaded room conveyors, number of units[2]	2,784	2,277	1,940	1,593	1,437	21

[1] *Sales of conveyors equipped with Duckbills or other self-loading heads are included with hand-loaded room conveyors.*
[2] *Includes pit car loaders and conveyors equipped with Duckbills or other self-loading heads.*

Table V. Mechanical loading and mining equipment in use in 1957, by States, compared with sales reported in 1958

	Mobile loading machines		Continuous mining machines		Scrapers		Room conveyors[1]		Coal-recovery augers	
	In use in 1957	Sales in 1958	In use in 1957	Sales in 1958	In use in 1957	Sales in 1958	In use in 1957	Sales in 1958	In use in 1957	Sales in 1958
Bituminous coal and lignite mines:										
Alabama	117	12	12	3	...	..	104	4	1	1
Alaska	5	..	1	...	1	..	8	...	...	..
Arkansas	....	..	1	...	...	..	22	...	...	..
Colorado	60	1	9	3	2	..	156	1	...	..
Illinois	179	..	38	3	...	..	8	...	...	..
Indiana	78	3	4	1	...	..	....	...	...	..
Iowa	5	..	...	...	...	..	....	...	...	..
Kentucky	574	16	30	11	...	..	100	6	64	13
Maryland	....	..	...	...	...	..	18	...	...	..
Montana, bituminous	9	..	...	...	...	..	9	...	...	..
New Mexica	2	..	...	...	...	..	1	...	...	..
North Dakota and Montana, lignite	2	..	...	...	...	..	....	...	...	..
Ohio	117	1	34	3	...	..	21	1	42	4
Oklahoma	5	..	...	...	...	..	78	...	...	..
Pennsylvania	794	8	291	24	2	1	509	14	46	6
Tennessee	35	1	...	...	1	..	25	...	11	5
Utah	152	..	16	1	...	..	8	...	...	..
Virginia	171	10	18	1	...	..	25	4	27	4
Washington	3	..	6	...	2	..	20	...	...	..
West Virginia	1,420	45	152	57	...	..	666	62	113	9
Wyoming	27	..	2	...	6	..	111	...	...	..
Total bituminous coal and lignite	3,755	97	614	107	14	1	1,889	92	304	42
Anthracite mines (Pennsylvania)	66	..	....	....	295	..	[2]1,437	21	(3)	3
Grand total	3,821	97	614	107	309	1	3,326	113	(3)	45

[1] *Includes hand-loaded conveyors and conveyors equipped with Duckbills or other self-loading heads.*
[2] *Also includes pit-car loaders.*
[3] *Data not available.*

Table VI. Units of conveying equipment sold for use in coal mines, 1957-58, by States

State	Bridge conveyors		Shuttle cars		Gathering and haulage conveyors [1]	
	1957	1958	1957	1958	1957	1958
Bituminous coal and lignite mines:						
Alabama	7	6	49	7	2	1
Colorado	..	..	5	3	2	..
Illinois	..	..	4	4	6	5
Indiana	..	..	3	8	1	8
Kentucky	16	3	30	39	15	7
New Mexico	..	..	2	2	...	..
Ohio	..	1	...	2	16	..
Oklahoma	1	..	...	...	2	..
Pennsylvania	14	11	99	18	40	14
Tennessee	..	..	2	...	1	..
Utah	..	..	30	7	5	1
Virginia	7	1	21	24	9	18
West Virginia	51	44	241	67	73	43
Wyoming	..	..	2	...	...	..
Total bituminous coal and lignite	96	66	488	181	172	97
Anthracite mines (Pennsylvania)	1	..	2	...	2	..
Grand total	97	66	490	181	174	97

[1] *Includes all gathering and haulage conveyors with capacity over 500 ft, except main slope conveyors.*

Table VII. Bituminous coal mechanically cleaned in 1957, compared with sales of mechanical cleaning equipment in 1958, by States.

State	1957			Annual capacity of equipment sold in 1958 (net tons)[2]
	Number of plants in operation	Net tons of cleaned coal	Output mechanically cleaned (percent)	
Alabama	34	12,417,096	93.6	(3)
Alaska	3	311,136	36.9	...
Arkansas	(3)	(3)	(3)	...
Colorado	[3]5	[3]1,394,913	[3]38.8	...
Illinois	60	42,455,159	90.3	3,268,000
Indiana	21	11,587,572	73.1	...
Kansas	3	583,704	77.9	...
Kentucky	87	43,264,992	57.9	2,052,000
Maryland	...	...	...	(3)
Missouri	11	2,744,594	92.2	...
Montana	2	10,531	2.7	...
New Mexico	1	21,646	15.8	...
Ohio	26	16,657,808	45.2	377,000
Oklahoma	3	600,522	27.4	...
Pennsylvania	99	52,601,639	61.6	2,393,000
Tennessee	4	722,462	9.1	(3)
Utah	5	2,986,881	43.6	(3)
Virginia	30	13,304,259	45.1	1,215,000
Washington	4	336,070	93.3	...
West Virginia	194	102,017,793	65.0	4,880,000
Wyoming	1	8,417	.4	...
Undistributed	...	...	...	520,000
Total	593	304,027,194	61.7	14,705,000

[1] *Based on average days were active in 1957 and 7.0 hours per day.*
[2] *Included in "Undistributed."*
[3] *Arkansas included with Colorado.*

five percent of the bituminous coal cleaned by wet methods in 1957, and the capacity of pneumatic equipment sold in 1958 was three percent of the tonnage pneumatically cleaned in 1957. Approximately 50 percent of the total capacity of cleaning equipment sold in 1958 was for additions to present installations and the remainder, 50 percent, comprised new plants.

Table VII gives data on bituminous coal cleaned in 1957, and the annual capacity of equipment sold in 1958, by States.

ANTHRACITE

(Continued from page 107)

thracite. Such factors as settling velocities, abrasion, and power requirements are being investigated. The design, construction, and testing of the equipment required for introducing solids into an hydraulic system is well underway. To date, the information available indicates that hydraulic hoisting is possible with a slurry containing about 25 percent solids; however, as no industrial process can readily handle this mixture, an efficient, economical dewatering method must be found.

Mine Water Control

A joint $17,000,000 program for mine-water control in the anthracite region was established in 1955 by the Federal Government and the Commonwealth of Pennsylvania. By the close of 1958, 22 projects with a total cost, contracted or estimated, of $8,000,000 had been approved. The cost of the projects is shared equally by the Federal and State governments.

The projects approved include pumping installations designed to control underground water pools, improvements in surface drainage, and backfilling strip pits to prevent surface water from seeping into underground workings. Pumping installations under construction or completed by the close of the year provided a total of 28 vertical turbine-type pumps, with an aggregate capacity of 131,000 gpm. The first pumping project was completed in 1958 near Wilkes-Barre. Others in the Northern, Southern, and Western Middle Fields are under construction.

The first surface project completed under the program was the improvement of a stream bed near Wilkes-Barre in 1957. Five other surface-drainage improvements were completed during 1958 in the Northern, Southern, and Western Middle Fields. Five new projects were under construction in the same producing fields at the close of the year.

Industrial Minerals

Most industrial minerals, tied to the fortunes of the growing construction industry, had another successful year

By JOSEPH L. GILLSON
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A BRIGHT spot in 1958 was the construction industry which finished the year slightly ahead of 1957. The total value of new construction, according to estimates of the U. S. Departments of Commerce and Labor, was one percent ahead of 1957. The only area of construction to show an appreciable loss was industrial plant construction, off 43 percent, and railroad construction, off 26 percent. There were so many other plusses, however, that these were counterbalanced.

The 50-odd units in the industrial mineral industry are tied to various construction segments of the economy. Magnesite, fluorspar, graphite, oxygen and refractory materials are sold to metal producers. Barytes and bentonite are sold principally to the oil drillers. Abrasives, ceramic materials, industrial diamonds, glass sand, feldspar, mica, talc, trona and sodium sulfate are used widely in the over-all economy and are affected by the general economic level. Other industrial minerals are major or minor components of every kind of building. These include those of largest volume, such as aggregates, asbestos, clays, diatomaceous earth, gypsum, limestone and other stone products, lightweight aggregates, perlite, pigments, rock wool, titanium oxide and vermiculite. Most of the producers of these products had a fairly good year.

Abrasives — Carborundum Co. increased its facilities at Niagara Falls for the manufacture of boron carbide, a material made in an electric furnace by reduction of pure boric acid with a low ash source of carbon. Solid shapes can be formed by hot pressing. The material has a hardness of 9.3 in Moh's scale, and will stand a temperature of 1000°F in an oxidizing atmosphere. Boron carbide will machine hard materials such as glass, porcelain and ceramics at a rate approximately 60 percent faster than its nearest competitor, silicon carbide.

Boron has an extremely high capture-cross section for thermal neutrons. Therefore, in addition to its uses as an abrasive, boron carbide is an ideal shielding or control rod material for nuclear reactors because it is resistant to high temperature, strong and hard, chemically inert, and is the cheapest form of highly concentrated boron.

Carborudum Co. has also developed boron nitride which offers promising pplications as a machine tool. Its principle use, however, is as a refractory.

Aggregates—Aggregate production comprises the largest segment of the whole mining industry, excluding fuels, measured both by volume and value. It is important to touch upon a few of the construction activities, because only by appreciating the magnitude of construction in this country can one realize where the huge tonnage of rock products is used.

The biggest item in the construction industry was new housing. It is a big consumer of gypsum and paints but not of the basic aggregates, although nearly every house has a stone or concrete foundation, brick walls and chimneys. In total this use is very considerable and supplies the market for thousands of small and moderate sized producers in cities and towns.

The big volume use for aggregates is in public and commercial construction. Seven and three-quarter billion dollars was spent on private commercial construction and 15 billion on public construction during 1958. A substantial portion of this went to the aggregate and cement producer, particularly in the cases of highway and dam construction.

For example, the total cost of all highway construction in 1958 was about six billion dollars, of which nearly half was federal money which pays for 90 percent of the Interstate system and 50 percent of the so-called ABC roads. A recent article stated that for every $1,000,000 of Federal road construction contracts 79,000 tons of aggregates, 17,000 bbl of cement and 21 tons of clay pipe will be used.

Joseph L. Gillson's comprehensive knowledge of industrial minerals has earned him wide acclaim. "Mining Congress Journal" is pleased to present once again his analysis and review of new activities and products of the industrial minerals industries.

Many enormous, though little publicized dam projects were underway in 1958. Glen Canyon dam in Colorado, for example, will cost $108,000,000. Dam construction, of course, requires millions of yards of aggregate, and is part of the market backbone of the aggregate industry.

A little appreciated, but major field of construction, is in that of sewage disposal and water supply. Major projects are under way in Boston, Providence, Baltimore, New York, and other cities across the country.

In even a brief review of construction activities, one should not forget the work on the St. Lawrence Seaway which was advanced during the year by the opening of the Long Sault Canal. The Seaway will be open to a 27-ft depth for the 1959 navigation season, and with it, a new era begins.

Another major project is underway at Niagara Falls, where a canal is being built to divert part of the river to a new power house. The largest power project in the free world will be constructed here, the power house alone costing $98,000,000.

In considering actual problems of aggregate production, note must be made of the increased use of heavy media separation to improve aggregate quality. This process applied to gravel has been described in several mineral industry publications. Costs are estimated at 14.5 cents per ton in plants handling 65 to 100 tph, but the selling price of the product can be increased by as much as 40 cents. There are now 13 plants using heavy media separation to beneficiate gravel; five are in Michigan and three in California. A study of scrubbers was reported in *Rock Products* for October. The use of jigs to up-grade gravel at Massilon, Ohio, was reported in the November issue. A series of three articles on sand washing was given in the August, October and November numbers of that magazine.

Asbestos—The biggest news during the year was the starting of the $36,000,000 operation at Black Lake in the Thetford district of Quebec by American Smelting and Refining Co., after four years of preparation. A description of the development was given in the October 1958 issue of *Mining Congress Journal*. A production of 100,000 tons of the fibre annually is forecast. The $9,200,000 mill is 14 stories tall, with operations on 11 floors. The facility will handle 5000 tpd of crude rock.

Although less spectacular than the development by Asarco, which involved

the draining of a 500-acre lake, another operation was started at Thetford Mines during the year. This is the operation of National Asbestos Mines Ltd., a subsidiary of National Gypsum Co. Its plant will have a capacity of 3000 tpd of crude rock and will produce 50,000 tons of fibre per year.

Carey-Canadian Mines replaced the East Broughton mine and mill of Quebec Asbestos Corp. with a new mine and mill which have a capacity of 2000 to 2500 tpd. Asbestos Corp. undertook a $5,000,000 expansion at its King and Beaver mines. Canadian Johns Manville spent $1,000,000 on its mill and a second shaft to its underground workings. The milling rate was increased to 800 tph. Last year Nicolet Asbestos Mines installed a new crushing plant, increasing mill capacity to 3600 tpd. The Eastern Townships are now producing asbestos at the rate of 1,000,000 tons of fibre per year. Total reserves are estimated at 950,000,000 tons.

An asbestos ore body at Baie Verde, on the Burlington Peninsula in Newfoundland, will be developed by Advocate Mines, Ltd., of Toronto, with which Patino Ltd. of Canada, Amet Corp., Inc., Financiere Belge de L'Asbestos Cement S.A., and Canadian Johns-Manville Co. Ltd., are associated. Johns Manville will have the operating contract.

Asbestos is produced in Ontario only at the Munro mine of Canadian Johns-Manville near Matheson. The mill has a capacity of 2200 tpd, but output has been slackened by a reduction in demand for the 4Y fibre, the only grade produced there. The company reports that a better grade of ore is found underground than was encountered in the west end of the open pit.

In British Columbia, Cassiar Asbestos Corp. has had a good year, with gross sales of about $9,000,000 as compared with $8,300,000 in 1957. Reserves are now said to be 9,000,000 tons, and may be increased by development on what is called the Cirque Valley side. The proposed Stewart-Cassiar road, 255 miles long, will give direct access to Tidewater.

In the Yukon, Conwest Exploration Ltd. opened the Caley asbestos property 40 miles northwest of Dawson and another called the Clinton Creek deposit. These, and one called the Letain in northern British Columbia, have been optioned to Cassiar.

In the U. S., Metate Asbestos Corp. constructed a processing plant on its property east of Globe, Ariz. In Venezuela, Amveco S.A. at Tinaquillo increased its production from 1500 tons to 15,000 tons, as a result of a modernization program completed this year.

Barytes — The United States continues to produce about 40 percent of the world's supply of barytes, with West Germany second, Mexico a close third, and Peru fourth, followed by Italy and the U.S.S.R. In the United States, the cut-back in new drilling for oil set the market back during the year, and one of the leading mines, Magnet Cove Barium Co. in Arkansas, was shut down from March until August. On the other hand, active development was under way in Kentucky by Mico Mining and Milling Co. In East Tennessee, Magnet Cove has acquired the old Williams mine at Del Rio which was worked 50 years ago when the principal demand for barytes was as a food adulterant.

Production of aggregate exceeds that of any other commodity in the mining industry, excluding fuels, by both volume and value

There was a lot of activity in the western states. Several moderately large barite mines are operating in Nevada and California. The Battle Mountain area in Nevada supports several crushing plants and a mill. In New Mexico, the Hansonburg district is active. The Sun Valley mine near Hailey, Idaho, is shipping barytes to various "mud" companies in the mountain areas. New producers are active near Addy, Wash., and near Greenough, Mont. National Lead Co. is mining two barite deposits near Greenough and has a mill on the Big Blackfoot River. Sunshine Mining Co. is developing a deposit on the Queen of Sheba Mountain, north of Colville, Wash. The Bunker Hill Co. has a 25 percent interest in a barytes mill at Coffeyville, Kan.

At Walton, Nova Scotia, Magnet Cove Barium Co. completed a vertical shaft with five compartments 977 ft deep, and is replacing its open pit with underground methods using block caving. Production for last year was 165,000 tons.

In British Columbia the Giant Mascot mine is producing barytes from its worked-out lead-copper-zinc-silver property near Spilli-Macheen. An estimated 250,000 tons of barytes are in the tailings pond, with an undetermined amount remaining in the mine.

In Venezuela two new processing plants have been opened by Baritina de Venezuela S.A., in which National Lead Co. has a substantial interest. Raw material is shipped from the mine on the island of Canamu off the coast of Brazil.

The principal producer in Australia is the South Australian Barytes Ltd. of Adelaide. The mine is located at Oraparinna, 300 miles north of Adelaide, and treatment and milling plant is at Quorn, 200 miles north of Adelaide.

Bentonite—Mining and milling of bentonite in Wyoming is centered in the vicinity of Osage, Moorcroft and Upton in the Powder River Basin. The clay is underlain by hard Mowry shale, and overlain by black shales of the Frontier formation. A stripping ratio of 8:1 can be handled economically. The Mowry shale makes an excellent working surface. Preparation of bentonite clay is relatively simple, consisting of grinding, drying and packaging.

A new plant at Colony, Wyo., 20 miles northwest of Belle Fourche, S. D., was built by the Archer-Daniels-Midland Co. of Minneapolis. The clay will be used as a binder for taconite pellets.

The uses of bentonite are listed as follows: (1) drilling mud, (2) foundry bonding, (3) cosmetics, (4) filter beds in sewage plants, (5) bleaching and decolorizing agent, (6) sealing for ditches and reservoirs, (7) a carrier in insecticides and a stabilizer in emulsions, and (8) in ceramics.

The mineralogy and origin of an unusual deposit at Hector, Calif., was described in *Economic Geology* for January.

Borax and Borates—High energy fuels are expected to require only about 1.5 percent of the current U. S. production of borates in 1959, according to D. R. Gibbons of Arthur D. Little Co. Nevertheless, the glamor

of boron's uses in rockets and missiles has kept the subject a live one, and has stimulated great activity in the Mojave Desert. Two large properties have been acquired close to that held by United States Borax & Chemical Corp. near Boron, Calif. Kern County Land Co. leased land northeast of Boron, and the drilling to date has indicated a very large deposit. It is said to contain 40,000,000 tons, but of colemanite, the calcium borate, rather than sodium borate found at Boron. Kerr-McGee has leased some 14,885 acres from Southern Pacific Land Co., and another 2000 acres from other owners. No drilling results have yet been reported.

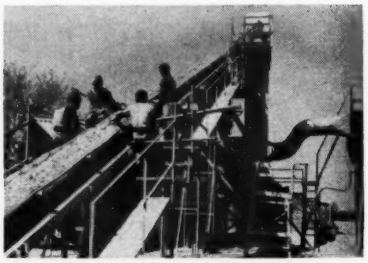
Last year was the first full year of operation for the new open pit of U. S. Borax & Chemical at Boron. The pit replaced three underground mines which have been shut down. Because the ore from the open pit is lower in grade than that formerly produced underground, the cost of moving the crude 150 miles to the refinery at Wilmington, Calif., was increased, and waste disposal areas were not adequate. These problems justified building a new refinery at Boron, similar in design to the old plant at Wilmington.

Production of borax by American Potash & Chemical Co., operating at Searles Lake some 50 miles north and a little east of Boron, was described in a California Division of Mines Bulletin. In the brines, sodium borate forms 1.63 percent of the brine from the upper bed and 1.96 percent of the brine from the lower bed. A so-called "main plant cycle" and a carbonation plant make up the basic sections at the Trona plant at Searles Lake. In the main plant cycle brines from the upper structure are evaporated and fractionally crystallized to recover eight primary chemicals. The carbonation plant processes lower structure brine to produce sodium carbonate and borax.

The discovery of large reserves of colemanite draws attention to the treatment of that mineral. Colemanite decrepitates upon heating; thus by screening after heating to 1300° F., the fine colemanite is recovered from the coarse waste. After grinding, the colemanite slurry is digested with hot sodium carbonate in reactor tanks. After reaction, the borate in the form of borax is water soluble. After filtration to eliminate impurities, the borax is crystallized.

The exciting new uses for boron chemicals tend to obscure the fact that the large tonnage produced, close to 1,000,000 tons per year, goes principally into old uses—about one-fourth to the glass and ceramics industry.

New discoveries of large borate deposits in Turkey were reported in *Mineral Trade Notes* for May. The deposits occur in the Bigadic and Kemalpaca areas, and may have reserves as large as 15,000,000 tons. The Turkish Institute for Mineral Resources Development is exploring a deposit at Emet in the province of Kutahya.



Foreign operations supply a substantial portion of the industrial minerals used in the United States

Clays—Several companies are working on processes to recover alumina from clays. The Anaconda Co., which operates an aluminum reduction plant at Columbia Falls, Mont., has been working on this for several years, and reports that it has developed a successful process. A new mine near Moscow, Idaho, with a 130-ft shaft was started in June. The company acquired about 3000 acres in the area. It shipped about 200 carloads of clay during the spring from its properties near Deary, Idaho. Anaconda joined with J. R. Simplot Co., of Boise, to finance research on the clay deposits of Idaho at the University of Idaho.

North American Coal Corp. and Strategic Minerals Corp. have formed a joint company called Strategic North American Corp. to develop a process for recovery of alumina from clay in coal mine refuse. The coal mines, called Powhatan mines, are 20 miles south of Wheeling, W. Va. The large aluminum reduction plant of Olin Mathieson Co. is at nearby Clarington, Ohio.

Less definite were statements that investigations were under way to use clay deposits in South Carolina for the same purpose. The Canadian Alumina Corp. has a pilot plant at the Department of Mines and Technical Surveys of Nova Scotia.

Diamonds — DeBeers Consolidated Mines, Ltd. completed a new treatment plant between the shafts of the Bulfontein and Wesselton mines. It has a capacity of 500,000 carats per month. The Bulfontein output will also include production from the adjacent Dutoitspan mine. The ore from that mine will be conveyed underground to the Bulfontein shaft. On the Namaqualand coast, DeBeers started operations at its Annex Kleinzee lease of 20,000 claims, having proved that there are at least 500,000 carats in the area that can be recovered at a profit.

East of the main Kimberlite area, in what is called the Boshoff area of the Orange Free State, Roberts Victor Diamonds Ltd. is developing an old pipe that had been worked intermittently since 1906.

In Southwest Africa, Diamond Dredging and Mining Co. has acquired a grant to prospect and mine in a strip 180 miles long, from a point south of Walvis Bay to Luderitz, and of a width three miles inward from the high water mark. This strip is on the seaward side of the area belonging to Industrial Diamonds of South Africa Ltd. and Diamond Mining and Utility Co.

At the operations of Consolidated Diamond Mines of South-West Africa Ltd. at Oranjemund, the old marine beaches which contain diamondiferous gravels are covered with sand up to 40 feet deep. The sampling operations include digging trenches two miles in length with diesel-driven, giant rubber-tired, four-wheel scrapers. In three years 12,500,000 cu yd of sand were removed by 30 of these scrapers at a rate of 57.5 cu yds per hr. For large scale stripping, bucket-wheel excavators were used that weighed 97 tons each and traveled ½ mph. Using only 40 hp, each machine removed 300 cu yd per hr. Working in series with two portable stackers, three wheel excavators removed 9,100,000 cu yd of sand. After the stripping of overburden, the diamond gravels are mined, loaded and conveyed to the nearest screening plant where the plus one-in. material is removed. The sand is then transported to the central concentrating plant.

Exports of diamonds from Angola totaled 477,150 carats in the first half of 1957. A new company was formed to cut and process diamonds in Lisbon.

There was a rush to the new Lofa district in western Liberia. Exports of diamonds totaled 799,987 carats in 1957, although most of the stones came from Sierra Leone and French Guinea. The Lofa River area has now been reserved for special large-scale mining concessions.

In Tanganyika, the death a year ago of J. T. Williamson left the future of the Mwadui mine somewhat uncertain. He discovered this mine in March 1940 and until his death produced diamonds to the value of $56,000,000. The mine employs 6000 workers and extracts kimberlite at the rate of 2000 tpd. The production in 1957 was 170,674 carats of gem stones and 201,928 carats of industrial diamonds. The Tanganyika Government and DeBeers Consolidated Mines Ltd. became equal shareholders in the Williamson Co. on August 13, 1958. The production of diamonds in the Belgian Congo totaled between 12,000,000 and 14,000,000 carats per year for the years 1954-57. About 25 to 35 percent of the Kasai diamonds are of gem quality, but the production from Lubilash yields only two to three percent of gems. The increased activity in the Lubilash sector (principally from the Bakwanga mine) resulted from firm demands for the famous Bécéka bort and was made possible

by the handling of all material by mechanical means. The dry land dredge and digging wheel permitted removing a greater thickness of overburden. Scrapers and shovels are used for handling gravel. Out of a total production of over 194,480,000 carats for the period 1926 to 1955, about 173,788,000 came from the company Societé Minëre du Bécéka of Lubilash.

The Belgian Congo produced 15,646,000 carats in 1957, followed by Ghana with 3,000,000, and South Africa with 2,578,000 out of a total world production of 25,890,000 carats. Brazil was the only important non-African country, with a production of 250,000 carats.

An important discovery of diamonds was made in the Republic of Yakutia, U.S.S.R. Pravda reports that the Yakutsk sources are richer and higher quality than those of the Belgian Congo. Six areas are identified. The probable reserve in the Malo-Botoubin and Daldino-Alakitsky areas is estimated at several million carats. Production from the major kimberlite pipe at Malo-Botoubinsky began in June 1957. The second most important pipe at Daldino-Alakitsky will be brought into production later. The percentage of bort is 80.76 percent. Previously the only diamondiferous region known in Russia was the Southern Ural, where the grades are low, and production unimportant.

Diamonds were actually found in Jerseyville, Ill., at a depth of 155 ft below the surface, in a water well drilling. The identification was made by the Central Illinois Testing Laboratories of Springfield.

A method of recovering microscopic diamonds is reported by the Diamond Research Laboratory of Johannesburg. A heavy mineral concentrate is treated electrostatically which concentrates the diamonds. The fine particles are collected in a mixture of bromoform and lead sulfamate, which has a specific gravity of 3.64, and in which the diamonds float and can be skimmed off.

In a report on its research activities, General Electric Co. hopes that the United States will become independent in industrial diamonds by producing synthetic stones with its high temperature, high pressure process. These stones are now sold for $2.96 per carat.

Diatomaceous Earth—Eagle Picher Co. opened its processing plant at Colado, six miles east of Lovelock, Nev. in September. It will handle ore from nearby properties in the Trinity Mountains.

Also in Nevada, Great Lakes Carbon Co. is continuing its diatomaceous earth operation near Basalt, in Esmeralda County, producing material which it calls "Dicalite." In California, the same company has shut down its plant at Walteria and moved equipment to Lompoc, where it has larger reserves.

Several small operators are developing properties in Kern County, California, near Fellows and Taft.

Dolomite—The Drummond Dolomite Co. of DeTour, Mich., has acquired a large new reserve on the south shore of Drummond Island in Lake Huron. A new plant designed to produce 2,500,000 tons per year will be ready in 1960.

In Nevada, U. S. Lime Products Co., now a subsidiary of Flintkote Co., quarries dolomite at the Sloan deposit, near Las Vegas. This is claimed to be a large and very high-grade deposit.

Feldspar and Nepheline—Lawson United Feldspar and Mineral Co., Minpro, N. C., made its first shipment after beginning operations in June, 1957.

The Spar-Mica Corporation Ltd., of Montreal, which made its first shipment in November 1957, claims to have one of the largest deposits of feldspar in the world. The open pit mine is at Cape Feldspar, Que., 40 miles east of Havre St. Pierre and 600 miles northeast of Montreal. Drilling has outlined 7,500,000 tons of high quality rock. The mill has a capacity of 100,000 tons of feldspar concentrate, 60,000 tons of quartz and 8,000 tons of muscovite.

Vast deposits of nepheline have been reported in the Tannutuwa area of Eastern Siberia. The area is west of Lake Baikal, near the Outer Mongolian Border. The deposit reportedly contains several hundred million tons. Since there are two new hydroelectric power stations in the vicinity, the Russians put especial importance on the possibility of producing alumina from the nepheline.

Fluorspar—The reduction in operating levels in the steel, aluminum and chemical industries, and the termination of several contracts for purchase by the GSA for the stock pile, both from domestic and foreign producers, caused a marked lowering in demands for most grades, particularly in the first half of the year. Quoted prices, however, remained about the same. Consumption of all grades was down about 25 percent during the first nine months, while consumption of metallurgical grade in the steel industry was off about 34 percent during the same period. Imports were down substantially, reflecting not only the reduced demand, but the decrease in Government purchases for the stock pile. All of the Government purchases were terminated December 31, 1958.

Congress voted an extension of the authority for additional purchases to December 31, 1959, but the President vetoed the bill in August. Encouraged by the apparent success of the quota system limiting the imports of lead and zinc ores and metal which was imposed in September, some of the domestic fluorspar producers were agitating at the end of the year for a quota system to limit the imports of both acid and metallurgical grade and a hearing is expected to be set for a date early in 1959 by the Office of Civil and Defense Mobilization.

Ozark Mahoning Co. completed a second shaft on its Deardorff property, Illinois, to a depth of 145 ft, and deepened the shaft at the old Parkinson mine from 180 to 400 ft. The Southern Illinois Mining Co. rebuilt its flotation plant and leased the barge loading facilities of Rosiclare Lead and Fluorspar Co. on the Ohio River. Mackey-Humm Mining Co., which has operated fluorspar mines in Hardin County for 20 years, has been sold to H. Evan Roberts of Los Angeles. Roberts acquired a controlling interest in the Hicks Creek Fluorspar Mining Co. and is a part owner of the Crystal Mountain mine in Darby, Mont., which is a large producer of metallurgical grade spar.

In the west, metallurgical production was under way in Montana, Utah and Nevada. So far as is known every fluorspar mine in New Mexico was shut down, although there had been plans to reactivate the Burro Chief Mine, near Tyrone, if a government contract could be obtained. The Monolith Portland Cement Co. of Tehachapi, Calif., took a lease on the Snowball group of claims in the Harqua Hala Mountains, southwest of Aguila, Ariz. A shaft was sunk to a depth of 100 ft.

In Newfoundland, the mines and plants of the St. Lawrence Co. were shut down, but Newfoundland Fluorspar Co., which is a subsidiary of Aluminum Company of Canada, resumed mining in February, after a shut-down of six months. During the idle period, major changes were made to crushing plant and loading facilities. The company expected to ship 60,000 tons of semi-concentrates to its flotation plant at Arvida, Quebec, during the year.

Dow Chemical Co. announced that it will build a flotation plant with a capacity of 100 tpd of concentrate in the Big Bend Country of northern Mexico. The plant will be on the Mexican side, and concentrate will be trucked 80 miles to Marathon, Tex. The mines, owned by a subsidiary of Dow, are at Agua Chile and Cuatras Palmas, 15 to 25 miles east of Stillwell's Crossing, in Mexico.

Operations on the Encantada and Buena Vista mesas were quiet during the latter part of the year, both on account of the heavy rains and because of over stocking at each of the flotation plants. Developments at the mine called La Purisima, on the west side of the Buena Vista mesa, have shown this to be the richest mine in the area.

Mining in the El Tule area was slow. Minera Rosala, which is the Mexican mining subsidiary of DuPont started construction of a small pilot plant to experiment with a dry

process of concentration to up-grade the run-of-mine crude, before shipment. Because of the necessity of shipping high grade crude mining to date in all of northern Coahuila has been a "gophering" process following the richest ore, and abandoning workings at lean places and also when the tramming distance became excessive.

There was an unconfirmed rumor at the end of the year that an American producer was considering building a flotation plant at Brownsville, Tex., to be based on Mexican ore. If so, there will be five flotation plants in northern Mexico or Texas using Mexican ore—four of which will be operated by American companies. Obviously the American mining industry is not united behind the demand for a stiff quota to be placed on imported fluorspar.

The writer of this review had an opportunity to visit a number of European mines during the summer. The largest individual producer in Europe is the Tórgola, in northern Italy, worked by the company called Pre-Alpina S.p.A of Milan. Considerable development was under way in Sardinia, where the two principal mines are the Monreale and the Silius. A new flotation plant was under construction by the Societe Monreale near Cagliari, to replace one at Gonosfanadiga. The flotation plant at the Silius mine, also near Cagliari, treats an ore running as high as 25 percent $BaSO_4$, nevertheless making acid grade spar.

The company Minerales y Productos Derivados continued a steady operation of the Osor mine near Gerona in northeast Spain. The company operating in Asturias, called Fluoruros S.A., has developed additional ore around the Caravia district, and has found that much of the ground along side of its various veins is sufficiently rich in fluorspar to justify working the surface dirt by open pit methods. The ore-bearing dirt is scrubbed in log-washers, and the fines are recovered in Dorr-Cones. The ore is shipped to the flotation plant at Pinzales, near Gijon, and the final concentrate is shipped from the port of Aviles. The old mine at Collada is continuing, the company having acquired the land adjoining, which permits following the vein down its dip of 45 degrees across the side property line. The Collada ore is floated at Pinzales but much metallurgical spar is made in jig mills, both at Collada and at Caravia.

Additional knowledge of European fluorspar was made available during the year in an article by A. Chermette, published in *l'Echo des Mines et de la Metallurgie* in June and entitled "Regards Sur la Production Mondiale de Spath-Fluor" It includes maps and photographs of the principal producing areas. The descriptions of deposits in Europe, Asia and South America are most authoritative.

Because of their low unit price, most industrial minerals must be mined and processed by high-capacity, low-cost mining methods

An article by A. H. Stuewe on Hydrogine Fluoride, published in *Chemical and Engineering News*, stated that 135,000 tons of HF (presumable as anhydrous) was used during 1957.

In regard to elemental fluorine, which has attracted so much interest as a potential rocket fuel, Stuewe says:

"A considerable amount of fluorine is used in making uranium hexafluoride. As an oxidizer in military rockets many problems will have to be solved. If at zero minus two seconds the control officer decides not to fire a Vanguard or Jupiter rocket, the liquid oxygen can be bubbled into the air with some beneficial effects. Things would not be so simple with fluorine. Nevertheless, ingenuity has solved tough problems before, and because of the tremendous power that flourine can unlock, some day its use may be considered as easy as the once difficult-to-handle HF is today. Bell Aircraft has announced that progress is being made in this application. Also Allied Chemical Co. is shipping tonnage quantities of liquid fluorine in tanks surrounded by liquid nitrogen."

Another interesting article on uses of fluorine compounds appeared in *Popular Science* for January 1959 under the heading "Amazing Fluorocarbons." Featured are electronic circuits of fluorocarbon resin that can be bent to fit into tight places. The wide use of Teflon for greaseless bearings in many 1959 automobiles was described. Teflon is used in submarines, the Convair B-58, and the Atlas and Thor missiles because it resists acid and sea water, and the highly corrosive "exotic" fuels. In conclusion, the article leaves the reader with the belief that everything from a permanent house paint, to permanent coolant for the automobile radiator, and permanent oil for its engine, and tires that will go 100,000 miles, will all come from fluorocarbon research.

Glass and Glass Fibers—Among the industries that are large users of nonmetallic minerals, none is better managed, nor more aggressive in finding new uses for its products than the glass industry. Several reviews of the glass industry appeared during the year. In January, under the heading "Masters of Their Craft," describing six leading companies, *Forbes* magazine said that if people are not living in a glass cage, they are certainly living in a glass age. Glass is what one expert called the closest thing to a universal material. It is used on the walls of factories and sky scrapers; as fiber glass it is used to make such assorted items as dresses, drapes, bodies for boats and cars, and for insulation. The automobile industry in the United States uses some $350,000,000 worth of glass annually. The electronics industry as we know it today could not exist without glass, and the same can be said of the food, pharmaceutical and cosmetics industries. In *Chemical Week* for August 2, figures are given of the glass industry's requirements of many industrial minerals and chemicals. Most of the figures are for 1957. Soda ash—1,500,000 tons, barytes—28,727 tons, fluorspar—32,482 tons, lime—276,399 tons, crude salt cake (sodium sulfate)—276,399 tons, borate—25 percent of the total U. S. consumption, lithium minerals—18,000 tons. The amount of silica sand used is not reported, but is of course, much greater than any of the above—running into many millions of tons.

Graphite—Korea increased its production of graphite greatly between 1956 and 1957, and now produces for about half of the world market. Russia is the second largest producer, followed by Mexico, Austria, Madagascar and West Germany. Production in the U. S. is very small.

In Ceylon, which used to be a very important producer of crystalline graphite, there are three major producers: Bogala Graphite Ltd, H. L. de Mal & Co.; and Kahatagaha Mines Co., Ltd. Production methods in most cases are antiquated, although the larger mines have been modernized.

One brief note about production in the United States was given in the *Engineering and Mining Journal* for April. General Graphite Co., which also owns the Alabama Flake Graphite Co., has blocked out more than 15,000,000 tons of ore averaging about four percent graphite at its Alabama mine. The mill on the property in Alabama has been leased to Industrial Minerals Corp.

Gypsum—The recession did not hit the two leading companies very seriously. U. S. Gypsum's net was down 2.1 percent in 1958 as compared with a five year average, and National Gypsum's 3.6 percent. The figures for the third company, Bestwall, were not immediately available, but it has increased its relative position considerably in the past five years. Earnings figures have shown that those companies that are integrated from raw material to finished products have done better than those not so integrated.

Bestwall went to court to get permission to start a gypsum mining operation near Grand Rapids, Mich.,

after the local township board had refused to authorized it. National Gypsum is developing a gypsum quarry in Tawas City, Mich. A channel, 250 ft wide and 12,000 ft long, is being dredged to bring lake steamers from Lake Huron into the plant.

Last year National opened a new quarry at Walton, in Hants County, Nova Scotia. In April the company shot down 380,000 tons of gypsum in one shot at its Milford quarry in Nova Scotia. Another new producer in Nova Scotia was the Canadian Gypsum Co., with a quarry at Miller Creek, near Walton. It has a capacity of 2,500,000 tons per year. In Newfoundland, the Atlantic Gypsum Co. continued operation on the west coast between St. Georges Bay and Fort aux Basques.

Out in Arizona, Union Gypsum Co. is operating a quarry 11 miles south of Winkelman and shipping 250 to 300 tpd to its plant in Phoenix. Verde Gypsum Co., with a quarry near Camp Verde, Ariz., is producing small quantities for agricultural purposes. In Nevada, Rock Island Gypsum Co. is operating a deposit in Washington County. The Fibre-Board Paper Products Co. has indicated reserves of 750,000,000 tons near Apex, Nev.

Another new company in the gypsum business is Flintkote, wtih a mine and plant at Sweetwater, Tex. Flintkote first acquired Insulrock Co., a fiber reinforced concrete slab manufacturer, the Van Packer Co., a prefabricated stack and chimney maker, the U. S. Lime Products Co., a major western lime producer, and Kosmos Portland Cement Co.

Iodine—Iodine is produced from oil-well brines in California by Dow Chemical Co. and Deepwater Chemical Co. Domestic producers supply a large part of national requirements, but the Chilean Nitrate Sales Corp. maintains stocks at Staten Island, N. Y. Approximately 2,500,000 lb were imported during 1957, mostly from Chile, but 500,000 lb came from Japan.

Lightweight Aggregate—An expanded shale called "Materialite" is being produced near Ottowa, Ill., by Material Service Corp. The product is made in the form of tough, hard pellets in three sizes, ¾ by ⅜-in., ⅜x3/16-in., and 3/16-in. down. The pellets weigh about 95 lb per cu ft, as compared with about 150 lb for natural aggregates. They are made from shale which is crushed to size, mixed with coal and fed to one of two 11¼ by 160-ft kilns, and fired at 2000° F.

Another expanded shale operation was built by Clinchfield Coal Co. at Clinchfield, Va. A product called Clinchlite is made from shale washed from the coal preparation plant. The product, called Aglite, is built in five plants in the United States. The new one was built near Minneapolis for the Central Lightweight Aggregate Co.

A material resembling lightweight cellular concrete was developed by Battelle Memorial Institute. Foamed aluminum is being produced by Dynamic Metals of Houston, Tex. It weighs 12 lb per cu ft and can be sawed, nailed, cemented and bolted.

Lithium—A review of recent developments in lithium were given in *Mining Magazine* for October. The author, M. Schofield, states that lithium is apparently essential in the manufacture of the hydrogen bomb, possibly as lithium deuteride. Lithium 7 may be used in control rods for reactors, when enclosed in a beryllium sheath. Lithium hydride is now used as an intermediate in the production of the boranes. Uses for other compounds are listed. LiOH is not deliquescent, hence is used widely for removal of CO_2. Lithium soaps formed from free fatty acids have wide temperature ranges, water resistance, and stability as greases and enjoy 28 percent of the market for greases. Litnium citrate is used in tonic beverages, lithium chloride in electrical batteries, lithium bromide in air conditioning, and lithium fluoride in welding fluxes and ceramics. Lithium carbonate dominates in the ceramic field.

The Atomic Energy Commission, which has been buying lithium hydroxide monohydrate, extracting the lithium 6 isotope, and returning the still useful tailings back to the producers, stated in the summer that it needed still more lithium. It now has reversed itself and states that it needs no additional lithium. Major lithium makers have contracts which run from nine months to two years. The contract with Foote Mineral Co. expires in May 1959, that of Lithium Corp. a year hence and that of American Potash and Chemical Co. in May 1960. The business had been a profitable one. Foote's average profit margin in 1955 to 1957 was 25.1 percent and Lithium Corp. had its best third quarter in history in 1958, making a profit of $237,000 on sales of $1,900,000.

Quebec Lithium Corp., which is a subsidiary of Sullivan Consolidated Mines, Ltd., plans to build a lithium refining plant at Rouses Point, N. Y., using a process developed by the Quebec Department of Mines.

There was very little activity in the lithium districts in Manitoba. Maintenance crews only were retained at the properties of Montgary Explorations Ltd. and Lithium Corp. of Canada.

In Brazil, Orquima of Sao Paulo announced that it will produce 300 metric tons of amblygonite per year which it will export to the United States.

In Rhodesia, the litigation between American Metal Co., and American Potash and Chemical Co. over the interest in American Lithium Chemicals was settled out of court. The settlement left American Potash holding 53 percent direct interest in American Lithium, Selection Trust Ltd. 24.75 percent and American Metal 18.03 percent. All three share in financing Bikita Minerals Ltd., which is developing a large lithium deposit near Fort Victoria, Rhodesia.

Magnesite—The operations in Nevada and in Washington were curtailed during part of the year because of decreased demand by the steel mills. Northwest Magnesite at Chewelah, Wash., was idled for a month in the spring. However, Basic Inc. which, with Standard Slag is one of the operators at Gabbs, Nev., has raised some $3,000,000 and plans to increase its processing facilities, and to expand the capacity of the equipment making caustic calcined magnesia. Two companies are planning to produce magnesia from sea water. Michigan Chemical Co. is building a plant at Port St. Joe, Fla., to produce 125 to 150 tons of high grade oxide per day. E. J. Lavino Co. of Philadelphia is building a plant at Freeport, Tex., to supply its refractories plants. The Westvaco Division of Food Machinery and Chemical Corp., which supplies periclase to the Lavino plant at Newark, Calif., is co-operating in the design of the Freeport plant.

A ten-year concession for the development of magnesite mines at Vavdon, Chalkis, Greece, has been granted to the Austrian American Magnesite Co. of Salzburg, Austria. The company also has purchased the magnesite processing plant at Chalkidike.

A large magnesite deposit was discovered in Colombia, near the city of Cali in the Valle del Cauca Department.

Mica—The United States continues to be a major producer of scrap mica, but produces very little sheet—the bulk of which comes from India and a little from Madagascar. The mica deposits of Nellore, India, have been worked for 50 years without showing signs of exhaustion, but modern methods must be applied or a goodly proportion of the recoverable mica will be lost.

An important new source of scrap mica was put into operation by International Minerals and Chemical Corp. by dredging a delta deposit in Davy Crockett Lake, which is the reservoir behind Nolichucky Dam, near Greeneville, Tenn. The mineral deposit is 40 ft thick in places and is estimated to contain 500,000 tons of scrap mica. A pilot plant has been operating to prove the feasibility of recovery by flotation.

Monazite and the Rare Earths—An authoritative report on the economic geology of the rare earth elements was given by Professor E. W. Heinrich of the University of Michigan in *Mining Magazine* of London, for May. First, the rare earth elements

Correlated with the growth in population and national wealth, new mining operations are starting every year

are listed, then the minerals that contain cerium earths, of which about 50 are tabulated, followed by those that contain yttrium, of which there are 18 (with some duplication with the cerium group).

The uses of the cerium group are listed as follows: 25 percent—carbon arc electrode cores; 20 percent—miscellaneous metal, and ferro cerium for sparking flints, alloy steels and rare earth-Zr-Mg alloys; 50 percent glass and ceramics, and polishing powders for lenses, mirrors, gemstones, etc.

Uses, actual and potential, for yttrium and the heavier rare earth elements are in nucleonics, as control rod materials; in alloys and cermets, and for deoxidizers of titanium and gadolinium; in electronics, as the radioactive ferrite, and for synthetic garnets; in ceramics and refractories, as catalysts, and for crystal activation, in the lithium iodide scintillation counters.

Heinrich says that the state of knowledge of the rare-earth elements today is approximately at the level of knowledge that uranium deposits were ten years ago. A wide variety of rare earth deposits has been found in the last several years in geological environments in which their presence had been unsuspected previously. It now appears that appreciable quantities of both cerium and yttrium elements can occur in almost every major category of mineral deposits.

Production of thorite from veins in Fremont County, Colo., and of xenotime from a migmatized schist near Black Hawk in Gilpin County, has continued on a small scale. The Trail Mines of Michigan Chemical Co. has accounted for about half of the thorite sold. Wah Chang Corp. has been milling some of this in an old tungsten mill in Sugar Loaf in Boulder County. Thorite-Copper sulfied veins in the Bitter Root Mountains on the Idaho-Montana boundary have been purchased by Sawyer Petroleum Co. of Los Angeles. Construction of the thorium recovery plant by Rio Tinto Dow Ltd. near Elliot Lake, in the Blind River district of Ontario, continued, and operation should begin in January 1959. Annual production of 100 to 200 tons of various thorium compounds is expected.

Nitrate—In 1957, 964,489 tons of Guggenheim process and 356,494 tons of Shanks process nitrate were produced in Chile. Of 1,354,427 tons exported, 556,487 tons went to the United States.

Perlite—The secretary of the Perlite Institute reported that an increasing amount of plaster uses perlite instead of sand as the aggregate, 53 percent in 1957 compared with 44 percent in 1955. Other uses which keep the demand expanding are as a carrier in insecticide dusts, in insulating concrete, particularly for lightweight roof decks, and as a loose fill insulation, paint filler, insulation board, etc.

In Colorado, Flexor, Inc., installed facilities to quarry perlite near the silver mining town of Silver Cliff, in Custer County. The crude rock will be "popped" in a plant in Denver.

Great Lakes Carbon Co. had been operating a mine near Rosita in Custer County, with a plant at Florence, 25 miles north. A group of residents in Florence filed suit against the company because of the dust, and received an injunction against the company. Damage suits totaling $102,000 are pending. The company shut the plant down, and is moving its equipment to Antonito, on the New Mexico line, and will draw rock from a deposit at No Agua, just south of the line. This deposit is claimed to be the world's largest known deposit of uniform grade perlite.

The dust problem at perlite plants is a serious one. U. S. Gypsum, which is another large producer of perlite, had been plagued with the same problem. Expanded perlite weighs only 8 to 12 lb per cu ft and is difficult to settle in the air. At its plant at River Rouge, Mich., U. S. Gypsum installed a new type of filter which they claim to be very effective.

In Nevada, U. S. Gypsum operates an open pit mine in the Trinity Range, seven miles from Lovelock. It is shipped to a plant at Empire, in northern Washoe County, where plaster and plaster board are made. Also in Nevada, Combined Metals Reduction Co., which was once one of the largest producers of lead-zinc ore in the state, is quarrying perlite at its Caselton mine, and shipping it by rail west for processing. Another producer in Clark County is Nevada Perlite Co.

Pumice—California and New Mexico are the principal domestic producers of pumice. Although Italy is the largest producer in the world, Greece is the principal source of imported pumice, and most of that is crude or untreated material. Practically all of the "manufactured" pumice comes from Italy.

Quartz and Other Crystals—The Amersil Quartz Division of Engelhard Industries has developed a new fusion process which produces synthetic quartz in more homogeneous form, with less thermal strain and fewer and smaller bubbles. Custom-forged blanks of the fused material are available in a variety of shapes, such as rods, cubes, briquets, prisms, and missile domes shaped like cantaloupe halves.

Quartzite—The production of quartzite for railroad ballast on the Chicago and Northwestern Railway System was described in *Rock Products* for November. After studying hundreds of raw materials, it was found that the high cost of production of quartzite could be balanced by the sharply reduced maintenance expense of the railroad bed. Quartzite stands up under the heavy pounding of fast freight trains; it fits well under the ties; and the roadbed stays clean since the rock does not crumble to dust. The quarry is at Rock Springs, Wis. Drilling, blasting, crushing and screening are described. A similar operation at New Ulm, Minn., was described a year ago in the same magazine, as was an operation at Clifton Forge, Va., to make silicones in the electric furnace at Alloy, W. Va.

Refractories—According to Arthur D. Little Co. 62 percent of industrial refractories are used by the iron and steel industry, and hence the more common refractories had a poor year. Three companies which devote their entire business to the manufacture of refractories accounted for 46 percent of the business in 1957, which in that year had a gross of $461,800,000. These are Harbison Walker, General Refractories and the A. P. Green Fire Brick Co. Other companies are Corhart Refractories (a wholly owned subsidiary of Corning Glass Works), and Mexico Refractories Co. Several companies produce refractories as part of their business. These are Kaiser Aluminum and Chemical Corp., Carborundum Co., Basic, Inc., Babcock and Wilcox Co., Blaw-Knox Co., and Johns Manville Corp.

The Mexico Refractories Co. modernized its plant at Mexico, Mo., and is building a plant at Stockton, Calif. Denver Fire Clay Co. announced construction of a new laboratory for research and development of refractory products.

Pacific Clay Co. entered into the mining and manufacture of refractory materials by acquiring all of the assets of Western Refractories Co., of Ione, Calif.

To conclude this section on refractories, it can be noted that a barter arrangement with the Philippines has been made to trade 200,000 tons of refractory chrome ore for surplus agricultural products held by the Commodity Credit Corp.

Salt—World production of salt, a commodity produced in almost every country (even Switzerland, although one wonders from what source), is estimated for 1957 at 77,400,000 short tons, of which over 30 percent was produced in the United States. China was second with 8,820,000 tons, followed by the U.S.S.R. with 7,200,000 tons. However, for all of this production, there is very little in the news about it.

International Salt Co., one of the largest producers in the United States, arranged to borrow $8,000,000 in order to develop a new mine in the Cleveland area. The United Salt Co. has completed a plant at Houston to produce salt under a Dow Chemical Co. patent, and to market it in packages for retail sale. The plant will produce 50,000,000 cartons per year.

A company called Utah Salt Co. has been organized to produce salt from ponds near Wendover, Utah, and ship it to the caustic chlorine producers in the Pacific Northwest. The salt is a by-product of potash recovery by Bonneville, Ltd.

In Nova Scotia, the Malagash Salt Co. has been sinking a 500-ft shaft at Pugwash, Cumberland County, through difficult material by a pre-grouting method carried out under the supervision of the Cementation Co. of Canada. The new plant wil handle 1000 tons per shift. About 90 percent of the production by Malagash Co. goes into the ice-control market on roads and highways of Eastern Canada. The other salt producer in Nova Scotia is the Sifto Salt Co. at Nappan, which produces salt from artificial brines.

Silica Sand—The production of a high quality silica sand from a white sandstone near Clayton, Iowa, was described in *Rock Products* for June. The stone is mined underground by the room and pillar method. At Murray, Ky., Murray Sand Co. shipped its first car to Corning Glass Co. in October. A paper on the Use of Standard Ottowa Testing Sands was given at the AIME meeting in February. In introducing his talk, the author stated that the silica industry is made up of small plants located near the consumer. There are 155 plants operating in 37 states. Testing sands are used for making standard tests on mortars, foundry sand, explosives and gypsum. Another special use is that of extruding liquid nylon through a cylinder packed with "20-30" Ottowa sand, causing the liquid to emerge as distinct strands which become the threads.

Most of the rest of the news on silica came from the West. Preparation of sand by froth flotation at a number of plants was described by Walter Lenhart in *Rock Products*. At all plants visited, clay removal is a major problem. Liquid cyclones are used at two plants for clay removal, and in one, a large agitated tank, soaked out the clay. Concentrating tables are used in one plant to lower the iron content. Chemical coagulation to settle slimes in reclaiming ponds was practiced in two plants.

A new plant was established at Camanache, near Sacramento, Calif., by Pacific Clay Products Co. to produce sand for glass plants. A flotation process is used to control the feldspar content, so that the product is delivered with 3¼ percent alumina. Plant capacity is 35 tph. A new plant at Lapwai, Idaho, was announced by Sunbeam White Sands Co.

Production of a high purity silica synthetically was announced by Cabot Carbon Co. at Tuscola, Ill. Silicon tetrachloride and hydrogen gas produce silica and HCl. The silica analyzes 99.9 percent SiO_2. The plant has a capacity of about two tpd.

Slag—Blast furnace slag, by-product of steel production, has been in short supply, as a result of production cuts in that industry. Nationwide slag sales have climbed to a current level of about 35,000,000 tons, as compared with 30,000,000 tons only five years ago.

The production of a cellular lightweight product during the pouring of molten slag is covered by a U.S. patent. The material can be poured so that it can be foamed uniformly.

Soda Ash—Although the production of soda ash was expected to hit a low of 5,000,000 tons in 1958, a good recovery is expected. Columbia Southern has built a new plant at Bartlett, Calif. Raw material is a saturated brine from Owens Lake. A new process has been developed to produce a high density ash which is free-flowing, dustless and uniform.

Intermountain Chemical Co. (90 percent owned by Food Machinery and Chemical) increased its natural soda ash capacity in Wyoming to 400,000 tons per year, late in 1957. A reduction in sales caused a slump during the summer, but in September 25 men were rehired. On a bid of $5.05 per acre, 4973 acres of federally owned land containing sodium carbonate deposits were leased. These properties are west of Green River, Wyo., where Intermountain Chemical has its plant.

Solvay Process Co. is doubling its capacity at Baton Rouge for dense soda ash, but its total capacity will remain at 750,000 tons per year. Olin Mathieson is increasing its capacity for dense soda ash at Saltville, Va.

There are four plants making soda ash from natural brines; Columbia Southern at Bartlett, Intermountain at Green River, American Potash at Searles Lake, and the West End Chemical Co., also at Searles Lake.

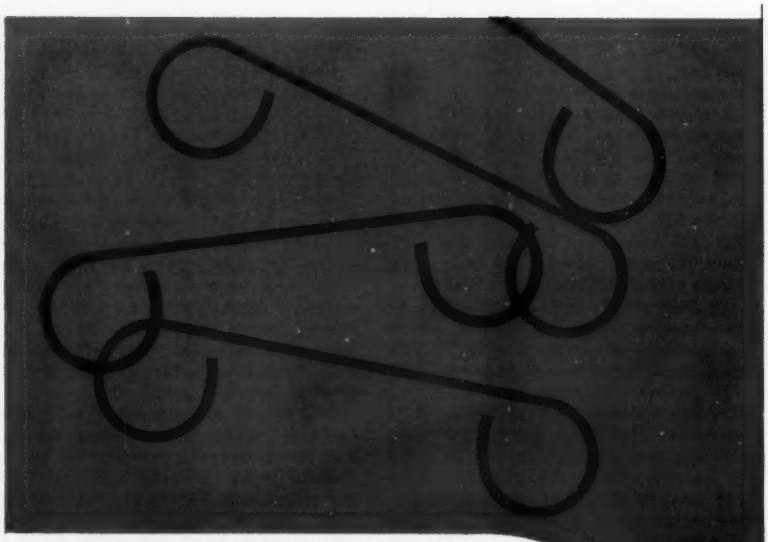
Sodium Sulfate—Details of the process for producing salt cake from Searles Lake brines is described in *Chemical Engineering* for August 11. West End Chemical Co. claims that its new cold (42°F) crystallization process is better than the evaporation process used by American Potash and Chemical Co. in its older plant. Actually, the latter company is already using cold crystallization in a cheap effective way, because, during the winter, brine is sprayed in the dry open air. Glauber salt crystallizes out, piles up on the ground and is trucked into the plant.

The recent decision by Ethyl Corp. to cease making hydrochloric acid by the Mannheim process results in removing some 55,000 tons of salt cake per year from the U.S. market. By 1959, natural material will account for 36 percent of the total production. In addition to the two plants at Searles Lake, Ozark Mahoning makes the salt from brines at Monahans, Tex., and William E. Pratt and Iowa Soda Products Co. mine the salt from deposits in Wyoming. No shortage is expected.

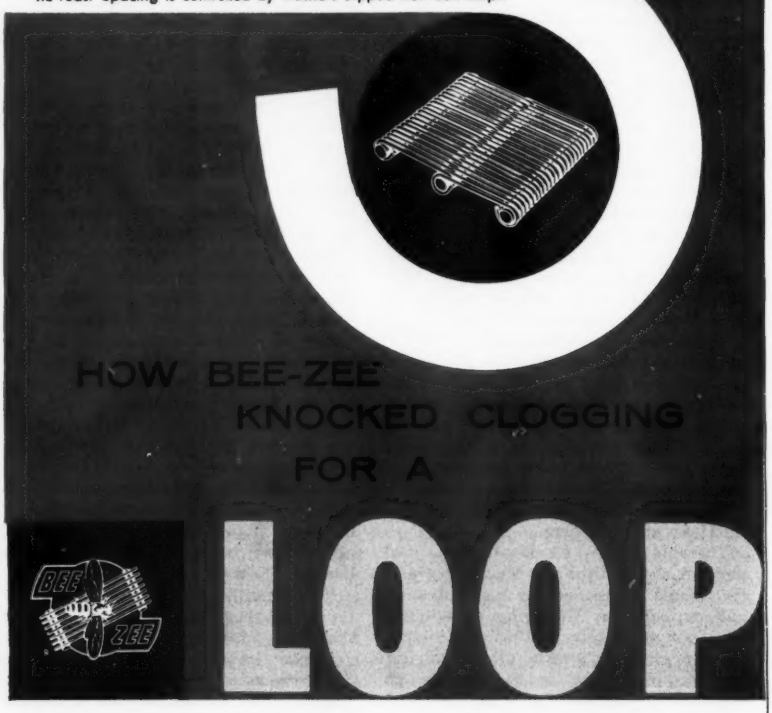
Titanium Ore—This was rather a frustrating year for the producers of titanium minerals. The sudden collapse of buying by the Government of titanium sponge cut the market off for rutile almost over night. This led immediately to the cancellation of construction by Union Carbide Co. of its plant at Amelia Island, Fla. Heavy Minerals, Inc., which had been producing minerals for Crane Co. at Aiken, S. C. and Panama City, Fla., no longer had a market. Metal and Thermit Corp., which had just opened a mine and mill at Hanover, W. Va., to produce rutile, found it had entered the market just at the wrong time. Worst hit were the Australian rutile producers who had increased both in numbers and in the capacity of many of their plants, but were depending almost entirely on the market in the United States.

The ilmenite business suffered both from the recession and from the fact that too many people were trying to get into the act. New deposits were discovered in New Jersey and Tennessee. According to the Assistant State Geologist of New Jersey, some 11,300,000 tons of TiO_2 are available in the New Jersey deposits. American Smelting and Refining Co. and American Metal Climax, Inc., have acquired properties there. Asarco has decided to shelve its plans for development but to hang on to its ownership. At the end of the year American Metal Climax seemed still to be considering an operation.

In central Tennessee both DuPont and Heavy Minerals drilled a number of areas, and nearly every other pigment manufacturer had men in the



NEW BEE-ZEE BH LOOP SCREEN is non-rigid to prevent clogging. Short, individual screening rods are looped – not welded – around tie-rods. Spacing is controlled by washers slipped between loops.



To give mine operators a solution to extreme clogging problems, Bee-Zee engineers produced a new type of screen operating on entirely new principles Bee-Zee's BH Loop Screen is made up of "loose" segments that multiply the action of a vibrator. Clogging is prevented without distorting accuracy.

Whether your own screening problems are highly unusual or "run-of-the-mine", Bee-Zee Screens can provide the answers–and make you money. Screening rods can be round, triangular or specially shaped. Electronically controlled welding fuses them to tie rods to form screens in all shapes, sizes and dimensions. Type or make of screening equipment is never a problem.

Write, wire or phone DIckens 2-5154. Ask for a specific recommendation or one of the complete Bee-Zee catalogs – or both.

BIXBY-ZIMMER ENGINEERING COMPANY
629 Abingdon Street, Galesburg, Illinois

area. DuPont had the most reason for acquiring a reserve there because of a new pigment plant under construction at New Johnsonville, just across the Kentucky Lake. Some property was acquired by DuPont near Lexington, Tenn., but the complex ownership of the property north of Camden, Tenn., led DuPont to abandon its exploration. The Bureau of Mines drilled an area in Texas, but apparently found no commercial occurrences.

The U.S. Bureau of Mines estimated that the total resources of National Lead Co. in Essex County, N. Y., are 121,500,000 tons of titanium bearing ore, of which about 100,000,000 can be developed by present day ore-dressing technique.

In Canada, Quebec Iron and Titanium Co. went ahead with the expansion of its plant at Sorel. Three new furnaces were installed in addition to the five formerly in service, raising the over-all output from 240,000 tons of titanium slag per year to 375,000 tons per year. The cost of the enlargement is estimated at $16,000,000. In mid September, all operations were suspended, and all wage roll employes were discharged, excepting stand-by personnel. About 500 persons were affected. The expected recovery of the titanium pigment business will probably allow the plant to reopen in 1959.

Combined Metals Reduction Co. is crushing 16,000 tons of titaniferous magnetite from the deposit at Iron Mountain, Wyo., for the account of Union Pacific Railroad which owns the deposit. The crushed ore is being stockpiled until changes are made in the plant which will enable it to reduce the ore.

Abroad, there were many developments. In Egypt, the General Ilmenite Co. has been organized to develop the Abu-Ghalaga ilmenite mines. Black Sands Co. is mining black sand deposits near Rosetta on the Mediterranean. In Mozambique, the Witwatersrand Brick and Tile Co. has purchased the controlling interest in Minerals Basicos de Moçambique Limitada, which owns a high grade titanium deposit at the mouth of the Pebane River. In Natal, the Anglo American Corp. began operation of a plant at Umgababa after $4,200,000 had been invested in the mine and plant. Capacity of crude sand is 7000 tpd. The method of mining is not described, but the concentration is being done, as in Florida, on Humphreys spirals, and in a dry plant with electro-static machines and magnetic separators.

The status of the titanium industry in Australia was reviewed in *Mining Magazine* for July. Production of rutile was 128,906 tons in 1957, of which 119,052 were exported. In the first quarter of 1958 production was 40 percent lower than in the corre-

(Continued on page 145)

wheels of government

As Viewed by HARRY L. MOFFETT of the American Mining Congress

THE 86th Congress convened on January 7 with a radical change in its composition. While the control of the new Congress continues to rest in the hands of the Democratic Party, it does so with majorities which rival the early days of the Roosevelt Administration.

The Senate is now composed of 64 Democrats and 34 Republicans, and the House of 283 Democrats and 153 Republicans.

The majority leadership in the Congress was settled with little debate. In the Senate, Lyndon Johnson of Texas remains Majority Leader, with Senator Mike Mansfield of Montana as Majority Whip, and Senator Carl Hayden of Arizona as President Pro Tempore. In the House, veteran Representative Sam Rayburn of Texas was again elected Speaker while Representative John McCormack of Massachusetts retained his post as Majority Leader.

The minority, however, did not settle its leadership without challenges by its more liberal members to instill new blood at the helm. In a surprise move, the House minority unseated Representative Joseph Martin of Massachusetts as Minority Floor Leader and named Representative Charles Halleck of Indiana to that post. In the Senate, Everett Dirksen of Illinois succeeded William Knowland as Minority Leader, with the post of Senate Minority Whip going to Thomas Kuchel of California.

The new Congress has not as yet been fully organized nor has it gotten down to consideration of legislative proposals, although the hoppers of both Houses have been filled with more than 3000 bills. The leaders have thus far decided to reorganize Congressional committees generally along the lines of the party divisions in the two Houses—almost 2-to-1 Democratic. They have, however, decided to retain the same majority-minority membership as in the last session on such important House committees as Ways and Means (15-10), Appropriations (30-20), and Rules (8-4). The filling of committee posts is currently under way, and once it is concluded, considerable activity can be expected on proposals relating to housing, statehood for Hawaii, labor and a host of other topics.

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Washington Highlights

86th CONGRESS: Convened Jan 7.
PRESIDENT: Calls for fiscal responsibility.
MINERALS PROGRAM: None now planned.
LABOR LAW: Drastic changes unlikely.
COAL RESEARCH: Government Commission sought.
WILDERNESS LEGISLATION: Sponsored anew.
PRICE CHANGES: Prenotification measure introduced.
DEPLETION: Cut-off change asked.
OIL DEPLETION ALLOWANCE: Under fire.
GEOPHYSICAL CLAIMS: Legislation being studied.
COAL: Defense survey by OMM.
IRON ORE: Tariff hearing held.
EXPLORATION: Loan regulations announced.

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The President has submitted his State of the Union message and his budget message, which will be followed with further details of his legislative program.

STATE OF THE UNION

Two days after the 86th Congress opened, the President personally delivered his annual State of the Union message, calling upon the lawmakers to adhere to a $77 billion budget and prevent useless expenditures which might tend to undermine our economy.

He strongly defended his military budget, a target of criticism by some legislators, stating that it will provide a sensible posture of defense.

President Eisenhower held forth hope that if a balanced budget is achieved in the year ahead, "we can look forward to a time in the foreseeable future when needed tax reforms can be accomplished." He stated that he has asked Treasury Secretary Anderson to study revision of the tax structure with a view to removing inequities and enhancing incentives for all Americans to work, save and invest, and promised to recommend tax revision as soon as fiscal conditions permit.

In general terms the President called for legislation dealing with civil rights, labor law revision, full employment, and agriculture, but left the spelling out of such proposals to future messages.

ADMINISTRATION PLANS NO MINERALS PROGRAM

Early this month, Interior Secretary Seaton told a news conference that he did not "now" expect to submit any new minerals stabilization plan along the lines of that presented to Congress last year. He did not fully close the door on offering minerals legislation if the occasion should warrant.

Seaton also said that he expects the current lead-zinc quota program to continue, and that further experience is needed before changes in the program are considered. The latter part of this statement has been challenged by industry officials.

The Interior Secretary also said that the voluntary oil import control program is still under study by a Cabinet Committee, but he would not state when the committee's recommendations might be made public.

Meanwhile, members of Congress are already introducing measures which would establish a minerals program along the lines of the Seaton plan of last year, renew Government purchase programs for some strategic minerals, and provide a free market for gold. It is too early to ascertain what action will be taken on them by the new Congress.

WHAT LABOR LAW REVISION?

Shortly after the recent national elections, experts of all descriptions pulled out charts or set forth analyses depicting that many successes at the polls were directly attributable to support of organized labor, and that for this reason the new Congress might

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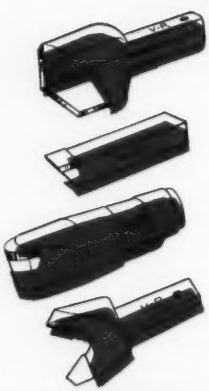

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undertake major surgery on the Taft-Hartley Act. Labor leaders flexed their histrionic muscles and announced confidently that they expected to achieve revision of the Taft-Hartley Act to prohibit the banning of union-shop agreements by State law. They also called for an increase in the minimum wage, expansion of coverage under the Wage-Hour Act, and enactment of a union reform bill similar to the Kennedy-Ives measure of the last Congress.

Since the elections, however, there has been time for sobering reflection, and many observers are of the opinion that no drastic changes in labor law will be approved this year. They do predict possible expansion of coverage of the minimum wage law and some mild curbs on labor racketeering.

The Administration will make known its legislative program in the labor field in the near future, and Senator Goldwater (Rep., Ariz.) has agreed to sponsor it in the upper House.

Meanwhile, Senator Kennedy (Dem., Mass.) has indicated that he will press quickly for action on the labor law changes which he sponsored in the last session. Kennedy has also secured a new approach to basic changes in the Taft-Hartley Act. At his suggestion, the Senate Labor Committee will create a nine-man commission to study the Taft-Hartley Act and its administration and to make recommendations as to its revision. None of the members of the Commission would be from Government. Five would be public representatives and two each would represent management and labor.

COAL RESEARCH BILLS REINTRODUCED

Several Senators and Representatives from coal-producing States have again introduced bills which would set up a Federal Coal Research and Development Commission. The three-man Commission would be empowered to develop new and expanded uses for coal, primarily through contracts with private educational institutions and research organizations, as well as with Government agencies.

A similar program was proposed more than two years ago to help the domestic coal mining industry combat loss of markets to other fuels, such as imported residual oil, and to alleviate unemployment in the industry. The plan was strongly endorsed by the American Mining Congress and other industry organizations, and a bill embodying the proposal was passed last year by the Senate. It was also approved by the House Interior Committee, but failed to reach the House floor during the hectic wind-up of the 85th Congress. Senate Interior Committee aides indicate that Committee will act on the proposal early in the session.

A strong drive for the legislation will be made by mining industry organizations.

WILDERNESS BILLS AGAIN SUBMITTED

Congressmen from many parts of the country have again introduced bills which would establish a National Wilderness Preservation System composed of large tracts of U. S. national forests, parks and other public lands, use of which would generally be limited to the aesthetic enjoyment of a relatively few wilderness enthusiasts.

The proposed legislation would ban commercial activity within the System, including mining and prospecting except in any area where the President specifically determined that mining activity better served the United States than its denial.

Congressional committees held hearings during the past two years on similar measures, but took no further action. The American Mining Congress pointed out to the Senate Interior Committee last July that legislation of this type "would result in a great disservice not only to the Western States but to the Nation as a whole." This view was echoed by mining and other natural resource industries of the Western States at field hearings of the Senate Committee in November, but proponents of Wilderness bills obviously have not been deterred from continuing to press for action by Congress.

PRICE PRENOTIFICATION BILL INTRODUCED

Senator Joseph O'Mahoney (Dem., Wyo.) has introduced a bill which would require producers of basic commodities to file with the Attorney General, the Federal Trade Commission and both Houses of Congress a 30-day advance notification of proposed price increases. The measure would require that such notifications be filed for commodities where 50 percent or more of the production comes from eight or fewer corporations. It also provides that the Federal Trade Commission hold hearings on the proposed price increases, and would give the FTC power to waive the 30-day waiting period where it considers that price increases are clearly justified.

There is no statement in the bill as to what the FTC should do if it finds price increases unjustified.

In introducing the measure, Senator O'Mahoney said that it is designed to provide a deterrent to industrial concerns "planning to raise prices unduly." He also stated that no new machinery would be required should his bill become law since the FTC already has authority to conduct investigations into price increases. At this writing no plans have been made for hearings on the proposal, but it is expected that Senator O'Mahoney will press for such hearings in the next few weeks. It is probable that the measure will be strongly opposed by industry generally.

"CUT-OFF" POINT FOR DEPLETION

In his budget message, the President asked Congress to enact legislation specifying the treatment processes which shall be considered mining for the purpose of computing percentage depletion "in the case of mineral products." Last year, the President noted, a similar recommendation was made only with respect to cement and clay products. The President said the proposed legislation is "designed to prevent an unintended extension of percentage depletion allowances to the sales price of finished products," and is prompted by court decisions. At this writing, the Treasury's specific proposal is not yet available, and the Ways and Means Committee has not yet set a date for hearings. However, it is quite obvious that developments in this field will be extremely important to the mining industry.

OIL DEPLETION UNDER FIRE

Several measures have been thrown into the hoppers of the House and Senate seeking reduction of the 27½ percent depletion allowance for oil and gas to 15 percent. Most of the bills have been sponsored by members of Congress who contend that the percentage depletion allowance for oil and gas is a major "loophole" in the tax laws.

An ardent advocate of cutting the allowance, Rep. T. H. McDonald (Dem., Mass.), declared the depletion rates for oil and gas are permitting the "giant oil and gas companies to avoid hundreds of millions of dollars of taxes."

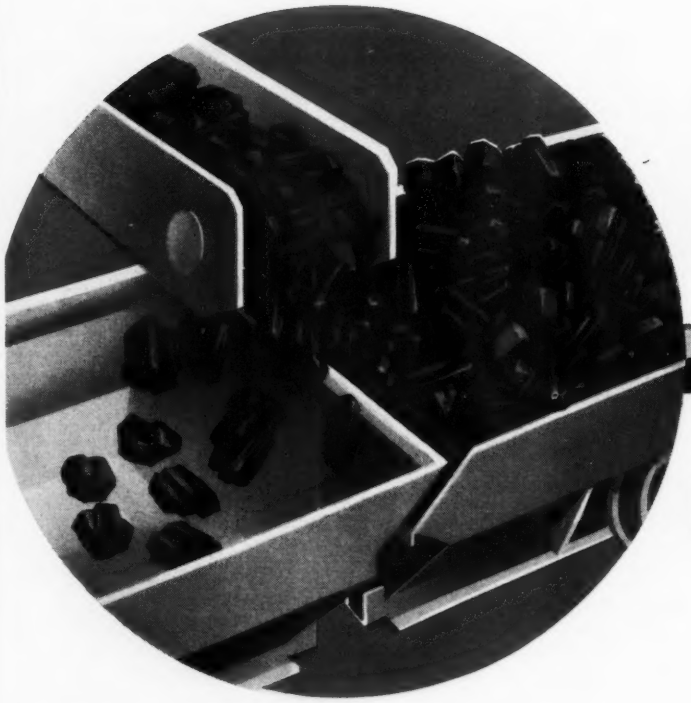
Whether these efforts will spill over into other mineral fields remains to be seen. A determined drive is being made by the oil and gas industries to retain the current rates and while there may be a real fight on this subject at the current session, observers point to the fact that both the House and Senate majority leaderships are in the hands of Texans who strongly favor retention of the existing rates.

Meanwhile, other bills have been introduced which would raise the depletion allowance on coal from the present 10 percent to 27½ percent.

GEOPHYSICAL CLAIMS?

It is understood that the staff of the Senate Interior Committee has under study a proposal to make possible the establishment of geophysical claims on the public lands. Details of the proposal are not available but it is possible that it may provide for geophysical or geological claims, limited in size and as to the length of time that they may be held before regular mining claims are located based on mineral discoveries.

(Continued on page 151)



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personals

E. P. Humphrey retired January 1 as president of Stonega Coke & Coal Co. He will continue as a member of the board of directors of several companies of the Stonega group. Humphrey, chairman of the National Program Committee for the 1959 AMC Coal Show, has been associated with Stonega, the Westmoreland Coal Co., and other allied groups for 23 years.

The retirement of **W. Kenneth Daly**, vice president and comptroller, the Anaconda Co., has been announced. **William E. Quigley**, assistant comptroller since 1956, has been named comptroller.

W. E. Quigley

W. K. Daly

Daly has been associated with Anaconda as a key figure in its accounting and financial affairs since 1917. In 1940 he became comptroller and in 1956 was elected vice president and comptroller.

Appointment of **Hubert H. Barber** as manager of Island Creek Coal Company's new Guyan Division has been announced. Barber will direct and supervise the operations of the Guyan Eagle Coal Co. mines No. 1, 4, and 5 and the Elk Creek Coal Co. mines No. 1 and 4, acquired by Island Creek in mid-January.

Richard C. Wells has been elected an executive vice president of Freeport Sulphur Co. He will continue as president of National Potash Co., a subsidiary owned jointly by Freeport and Consolidation Coal Co., which he has headed since its organization in 1955.

The board of directors also elected three other officers of the company. They are: **William B. Porterfield, Jr.**, assistant vice president, formerly vice president and sales manager of National Potash; **Palmer H. Evanson**, assistant controller, and **Robert M. McArthur, Jr.**, assistant controller.

I. N. Bayless has retired as president of Union Pacific Coal Co. He has been succeeded by **V. O. Murray**, former general manager, with headquarters in Rock Springs, Wyo.

Bayless entered the mines when he was 18 and has worked "every classified mining job" during his 52-year career. He joined Union Pacific in 1929 as assistant general manager and was named general manager in 1938. In 1944 he became president.

V. O. Murray

I. N. Bayless

Among the first to take advantage of mine mechanization, it was through his efforts the first 5000-tpd mine in Illinois was completely mechanized. Later, under his direction a complete transition to mechanization took place in the operations of Utah Fuel Co. His continuous efforts to increase safety and efficiency in the mines of UP Coal resulted in winning the National Sentinels of Safety Trophy 14 times in 21 years.

International Minerals & Chemical Corp. recently announced appointment of two directors and a chemical research manager in its new Research, Engineering and Development Division. **H. Turner Loehr** was named director of engineering, and **Lawrence A. Roe**, director of development. **Walter Lincoln Hardy** will be manager of chemical research.

Directors of other departments in the new division are **M. B. Gillis**, research, and **F. C. Kruger**, mining and exploration.

The Utah Mining Association has announced the election of the following officers for 1959: **Lockwood W. Ferris**, president of Bonneville, Ltd., as president; **Oscar A. Glaeser**, vice president and general manager, Western Operations, U. S. Smelting Refining & Mining Co., as first vice president, and **S. K. Droubay**, vice president and general manager, United Park City Mines Co., second vice president.

Consolidation Coal Co. has announced the retirement of **A. Vernon Sproles** as president of Consol's Pocahontas Fuel Co. Division. At the same time the election of **Peter P. Ferretti** as the Division's new president was announced.

Sproles has been associated with Pocahontas and its predecessor company for 50 years, having started in 1909 as a member of the engineering corps in one of the company mines. In a series of promotions he became safety director, assistant general superintendent, and later general superintendent. In 1953 he was elected vice president in charge of operations.

A. V. Sproles

P. P. Ferretti

Following his discharge from the Army in 1946, Ferretti represented Goodman Manufacturing Co. in the Huntington, W. Va., territory. In January 1948, he joined the staff of Clinchfield Coal Corp. as a production engineer. In 1952 he joined Pocahontas Fuel Co. as assistant superintendent of its Itmann mine, became assistant general superintendent of mines in 1953, general superintendent in 1954, and vice president in 1957.

Robert J. Morrison, vice president and secretary of American Cement Corp., has been elected president of Peerless Cement Co., a division of American with headquarters in Detroit. He will continue as a vice president and a member of the Board of Directors and the Executive Committee of American.

Morrison, who was formerly executive vice president, administration, of Peerless, succeeds **Walter C. Russell** who will continue as vice chairman of the Board and chairman of the Executive Committee of American.

Frank Thomas has been named general manager of Stearns Coal & Lumber Co., Stearns, Ky., succeeding **R. W. Henderson**, retired.

Appointment of **Andrew Bela** as refinery superintendent of its Boron, Calif., plant has been announced by the Pacific Coast Borax Co., Division of United States Borax & Chemical Corp.

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combine the advantages of DETACHABILITY with one-piece SIMPLICITY

For small-hole drilling, in sizes from 1¼" to 1⅝", Ingersoll-Rand now offers Carset bits with a tapered socket connection that combines the rugged simplicity of a one-piece carbide-insert steel with the convenience, flexibility and long-range economy of conventional threaded bits. A brass shim between bit and rod equalizes impact pressure in the connection. Bits are removed by a simple knock-off block.

With these I-R Socket Bits and tapered rods you get the unsurpassed *drilling speed* and service-proved dependability of a genuine Carset bit with four Carboloy inserts—plus all these other time-saving, cost-saving advantages:

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- A broken steel is not a total loss—you save the bit and can re-grind the end of the steel.
- Bit grinding is faster and easier—operator doesn't have to manipulate a long length of steel.

For maximum convenience and long-range economy on your next Jackleg drilling job, try I-R Carset Socket Bits. Bits and rods are available now in the following standard sizes:

I-R CARSET SOCKET BITS

Gauge	Symbol	Weight
1¼"	1¼ — XLS-5	10 oz.
1⅜"	1⅜ — XLS-5	12½ oz.
1½"	1½ — XLS-5	13 oz.
1⅝"	1⅝ — XLS-5	15 oz.

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Length	Symbol	Wt. per ft.
18", 24", 36" 48", 54", 60" 72", 84", 90" 96", 108" 120", 144"	JABXLA-(length)"	2.4

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John A. Stachura has been appointed vice president in charge of operations for Enoco Collieries, Inc., a subsidiary of the Enos Coal Mining Co. Stachura began his mining career in 1930 at the Duquesne Light Company's Harwick mine where he was general assistant foreman. In 1941 he went to the Warwick mine as safety engineer where he was later promoted to assistant superintendent. From January to October 1949 he worked with the Pennsylvania Department of Mines, and in October 1949 he joined Enoco Collieries, Inc. as general superintendent.

John Towers, Jr. has been appointed manager of the Carteret, N. J., plant of U. S. Metals Refining Co., a subsidiary of American Metal Climax, Inc. He succeeds **Freeman H. Dyke**, who recently announced his retirement.

H. Y. Bassett, president of Calumet & Hecla, Inc., has been named chairman of the board and chief executive officer of the Alabama Metallurgical Corp., which has broken ground for a $3,500,000 magnesium producing plant at Selma, Ala. Calumet & Hecla, Inc. owns 70 percent of the stock of Alabama Metallurgical Corporation. Brooks & Perkins, Inc., of Detroit, owns the balance.

Promotion of **S. P. Carter** to chief engineer of Armco Steel Corporation's West Virginia coal mines has been announced.

Carter joined Armco in 1934 as an electrician at the company's Nellis, W. Va., mine.

In 1941 he became inside maintenance foreman and after serving in the U. S. Air Force, returned to Armco's mines in 1946 as power engineer. He was advanced to maintenance superintendent later that year and was promoted to superintendent of maintenance for all Armco's West Virginia mines in 1949.

Stanley W. McDougall, manager of Kellogg Operations for The Bunker Hill Co., retired January 1. He will be retained as a mining consultant.

McDougall joined Bunker Hill in 1924 as an underground surveyor and shortly became a mine shift boss. Later he was promoted to assistant foreman, division foreman and foreman. In 1934 he succeeded his father as mine superintendent, and in 1954 he became manager of mines. He has been manager of Kellogg Operations since 1957.

Appointment of **D. R. Dunham** as manager of the Columbia-Southern Chemical Corp. coal mine at Midvale, Ohio, has been announced. He succeeds the late **Paul C. Beutel**, who died suddenly last November.

W. H. Goodrich, general manager of Kennecott Copper Corporation's Chino Mines Division since 1947, retired January 1.

Goodrich became associated with Chino in 1937 as assistant mine superintendent. He was named general superintendent of mines in 1941 and in 1947 was made general manager.

Along with his duties as manager of one of the state's largest industrial installations, Goodrich has been prominent in civic affairs. He has been a member of the New Mexico Economic Development Commission, a director of the New Mexico Taxpayers Association, and a member of the board of regents of New Mexico Western College. He holds an honorary Doctor of Engineering degree from New Mexico A. and M. College.

Hugh B. Lee, Jr., was elected president of Maumee Collieries Co., Terre Haute, Ind., at the company's recent annual meeting. In moving up from executive vice president, Lee succeeds his father who was elected vice chairman of the board of directors.

— *Obituaries* —

Charles C. Whaley, 77, vice president and sales manager of the Myers-Whaley Co. until his retirement in 1954, died December 27. Well known in the coal industry, Mr. Whaley took a leading part in the mechanization of coal mines and was instrumental in the rapid transition from hand loading to mechanical loading that occurred in the late 1920's and the 1930's. He was active in the Manufacturers Division of the American Mining Congress and was a charter member of the "Old Timers Club."

Henry Krumb, 83, distinguished mining engineer and former trustee of Columbia University, died December 27, in New York City.

Mr. Krumb, for many years a prominent consulting mining engineer, was best known for his original examination of porphyry copper mines. Mines in which Mr. Krumb conducted original examinations include Utah Copper, Boston Consolidated Copper, Ohio Copper, Nevada Consolidated Copper, and Ray Consolidated Copper. He was a director of many mining companies, among them the Newmont Mining Corp.

A. W. Witherspoon, 82, for many years a director of Hecla Mining Co., and at one time, for about a year, president of that company, died during the early part of December. He was a retired attorney, and at the time of his death was chairman of the board of the Old National Bank in Spokane. When he retired from legal practice in 1957, he was senior member of the law firm of Witherspoon, Witherspoon and Kelley.

John H. Eggers, president of the Mining Association of Southern California, passed away January 9 in Los Angeles.

Charles E. Tonry, 55, director of Source Materials Procurement Division for AEC's Grand Junction Operations Office, and a veteran of 32 years in mining and mineral industries, died suddenly of a heart attack December 18.

Mr. Tonry began work for the Government late in 1951 at the Rifle oil shale demonstration plant as chief of the cost estimating unit and chief of planning and evaluation. He joined the AEC in 1954 as director of the Processing Division, a job which made him responsible for carrying out the ore processing and uranium concentrate buying program for the nation.

Samuel Woodhead, 73, secretary-treasurer and purchasing agent of the Independent Coal & Coke Co., died in Salt Lake City December 28 following a heart attack suffered while shoveling snow.

Edgar R. Phillips, 65, sales manager for Lee-Norse Co., Charleroi, Pa., designers and manufacturers of coal mining equipment, died of a heart attack December 9 .

Before joining Lee-Norse six years ago, Mr. Phillips was sales manager for the Pittsburgh Gear Co., and prior to that was a sales representative of the Joy Mfg. Co. and Timken Roller Bearing Co.

Widely known in coal mining circles, Mr. Phillips held membership in the Western Pennsylvania Engineers Society and the American Mining Congress.

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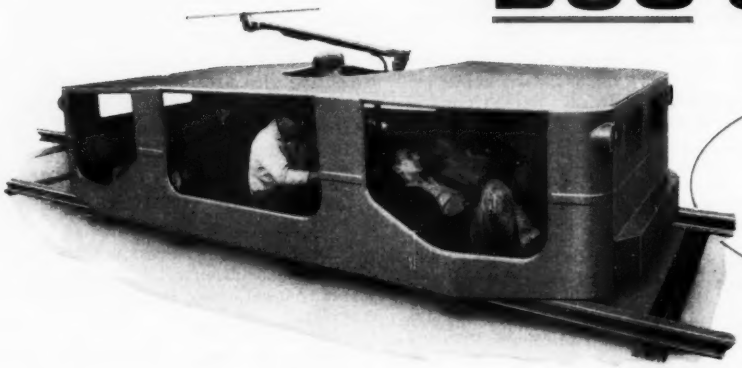
you take your profits on ~~the~~ *every* run with the Lee-Norse BUS & JITNEY



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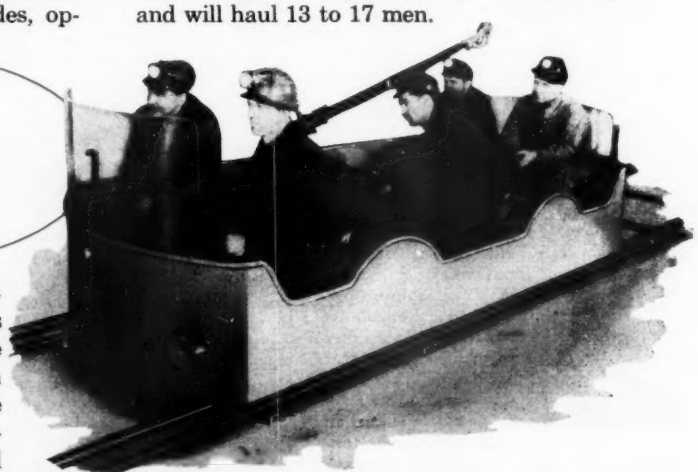
Lee-Norse
MINE JITNEY



■ The Mine Jitney is the "Jack-of-all-Trades" of the mine fleet because its versatility enables it to be used on the regular job and for emergency. It can handle the job of furnishing fast, safe transportation of key personnel, maintenance crews and special groups; and can double up as an ambulance or fire-fighting equipment car. Designed with twin braking systems for added safety. Powered with either 5 or 7½ H.P. motor. Holds up to 7 men comfortably. Optional equipment: Plexiglas windshield, fire extinguisher, stretcher equipment.

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SPECIALISTS IN COAL MINING EQUIPMENT

NEWS and views

Anaconda Combines Aluminum Subsidiaries

The Anaconda Co. has announced the reorganization of its aluminum activities. Two wholly-owned subsidiaries, Cochran Foil Corp. and American Aluminum Co., have been merged with a third, Anaconda Aluminum Co. The result is a single organization with assets of more than $140,000,000. Executive offices for Anaconda Aluminum Co. will be located at Louisville, Ky.

Archie P. Cochran was elected president of the consolidated subsidiary. He was the founder and president of Cochran Foil Co., acquired by Anaconda last April and reorganized as Cochran Foil Corp. Cochran succeeds Russel B. Caples, who was president of Anaconda Aluminum from March 1953 until his retirement from that post at the end of 1958. Caples will continue as vice president of the parent company and as a director of Anaconda Aluminum.

As a result of the merger, Anaconda Aluminum will be essentially an integrated organization, embracing each phase of aluminum production from the reduction of alumina to pig and ingot through to the fabrication of such commercial products as rod, tube, sheet, extrusions and foils.

New Coal Pipeline

R. H. Henry, a coal broker and president of the newly organized Youngstown Coal Pipeline Co., has announced construction of a $10,000,000, 30-mile pipeline to take coal from East Liverpool to Youngstown, Ohio. The project will have a capacity of 3,000,000 tons a year when completed. Construction is scheduled to start this spring.

National Gypsum to Buy Huron Cement

National Gypsum Co. is negotiating to acquire Huron Portland Cement Co., according to Melvin H. Baker, chairman of National Gypsum. He said that directors of both companies have agreed on a basis for exchanging shares of stock under which the cement company eventually would become a wholly-owned National Gypsum subsidiary.

National Gypsum is a leading producer of building materials with 40 plants in the United States and Canada. Huron Cement is believed to have the largest cement plant in the world at Alpena, Mich. It has a fleet of lake vessels and 12 distributing plants on the Great Lakes, including one in Buffalo.

Baker pointed out that the acquisition of Huron Cement would add "a basic product line for future development." Present National Gypsum product lines include gypsum, lime, asbestos, paint, insulation and ceramics.

Princess Elkhorn and Powellton Coal Merge, Expand

Princess Elkhorn Coal Co. and Powellton Coal Co. have merged into a newly organized company with a new name—Princess Coals, Inc. In addition Princess Elkhorn and Powellton have purchased all the stock of Sycamore Coal Co. and Cinderella Coal Corp., both to operate as wholly-owned subsidiaries of the new corporation.

Another totally-owned subsidiary will be Princess Coal Sales Co., present marketing concern of Princess Elkhorn and Powellton. All together, the combined companies will have an annual production of 3,500,000 tons.

Princess Elkhorn operates in Floyd County, Ky., and Powellton in Logan County, W. Va. Sycamore, with mines near Williamson and Grundy, Va., and Cinderella, with operations in Pike County, Ky., and near Richwood, W. Va., have a combined production of 1,000,000 tons a year.

David L. Francis, president of Princess Elkhorn and Powellton, will be president of Sycamore and Cinderella as well as the other companies.

Freeport Sulphur Subsidiary Renamed

The name of Cuban American Nickel Co., a Freeport Sulphur Co. subsidiary, has been changed to Freeport Nickel Co. Freeport Nickel will operate a refinery for nickel and cobalt at Port Nickel, La., on the Mississippi River below New Orleans. Beginning in the summer of 1959, the subsidiary will produce 50,000,000 lb of nickel metal and 4,400,000 lb of cobalt metal annually.

Hydrocarbon Liquid Fuels from Coal

Consolidation Coal Co. and Standard Oil Co. (Ohio) have announced an agreement by the two companies to undertake a joint basic research project to explore methods of manufacturing hydrocarbon liquid fuels from coal. The move was announced jointly by G. A. Shoemaker, executive vice president of Consol, and Elliott B. McConnell, vice president for manufacturing, Standard Oil.

The agreement is a natural development based on experience of the two companies working together in a jointly owned affiliate, Mountaineer Carbon Co., Cresap, W. Va., which is engaged in the calcining of coke for the aluminum industry. Consol has been engaged in this field for some time at its laboratory in Library, Pa. Standard Oil expects to begin active participation in its research center and its Process and Product Development Division Laboratory in Cleveland during 1959.

Research officials from both companies say that at this time it appears that from five to ten years of research and development work will be required before the project will reach the point that consideration can be given to the commercial possibilities.

Humboldt Announces Expansion Program

Cleveland-Cliffs Iron Co. and Ford Motor Co. have announced a multi-million dollar program to expand facilities for mining and concentrating iron ores in Michigan's Upper Peninsula. This program would double the production capacity of Humboldt Mining Co., located 26 miles west of Marquette. Humboldt, owned 50 per-

(Continued from page 141)

H&L Teeth that really dig

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H & L Teeth That Really Dig
Are Forged Alloy Steel
Stay Sharp Longer
Give Greater Penetration with
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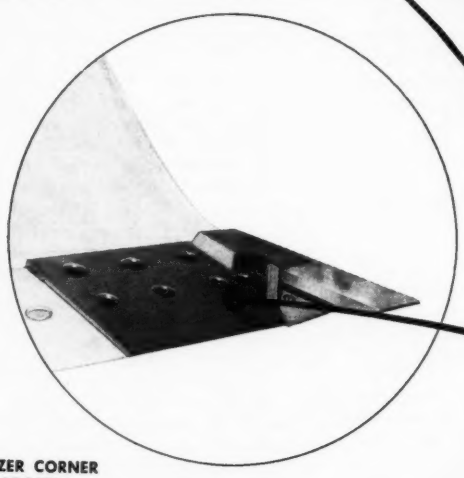
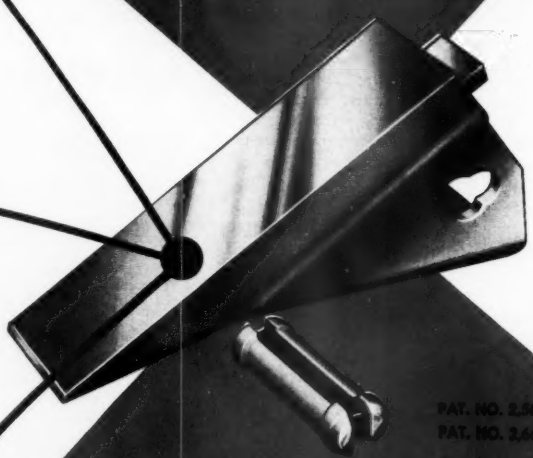
Quick Changing Flexpin
For Less Down Time



DOZER CORNER ADAPTER



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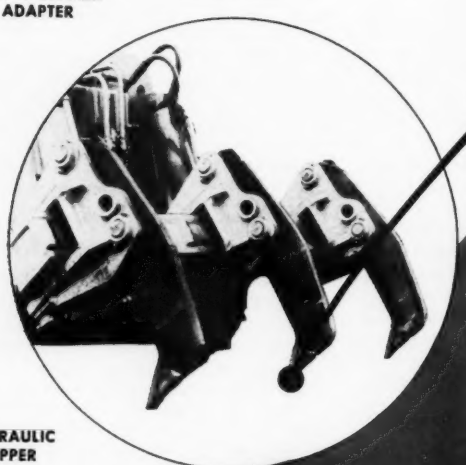


HYDRAULIC RIPPER

There is No Substitute For Forged Alloy Steel!

H&L TOOTH CO.

1540 SOUTH GREENWOOD AVE.
MONTEBELLO, CALIFORNIA

(Continued from page 139)

cent by Ford and 50 percent by Cleveland-Cliffs, now has an annual capacity of 320,000 tons of concentrate per year.

An outstanding feature of the project will be the installation of pelletizing equipment to produce high-grade, marble-sized pellets from the ore concentrates. Construction work is under way and commercial production of pellets will be started in mid-1960.

The Humboldt operation will make the first use of an improved pelletizing process to make pellets from the hematite ores found in vast quantities in northern Michigan. The expansion work will include addition of a second concentrating unit, similar to one now at the site, and construction of a pelletizing plant capable of converting the full concentrate output into pellets. Proven reserves of crude ore at the Humboldt site are estimated to be sufficient to yield 15,000,000 tons of pellets.

Henry Hebley Retires

Consolidation Coal Co. has announced the year-end retirement of Henry F. Hebley, research consultant, who had been associated with Consol and its predecessors for nearly 20 years.

Born in New Zealand, Hebley was graduated from the Seddon Memorial Technical College. He went into copper mining in Australia, and later came to the United States to continue his work in Utah and Arizona.

Following World War I he was engaged in mining work in Canada, Germany and the Donetz Coal Basin of Russia, as well as in virtually every coal field in this country. He joined Pittsburgh Coal Co. in 1939 as product control manager and became director of research a few years later. After the formation of Consolidation Coal Co., of which Pittsburgh Coal is a division, he was appointed research consultant in charge of work to reduce air and stream pollution.

Hebley is a member of many professional societies both here and abroad. In 1945 he was honored by being advanced to the grade of "Fellow" of the Institute of Fuel, London, England, and in 1951 was honored by the American Society of Mechanical Engineers with a similar grade. In 1953 he was the recipient of the Percy Nicholls Award, granted jointly by the A. S. M. E. and A. I. M. E.

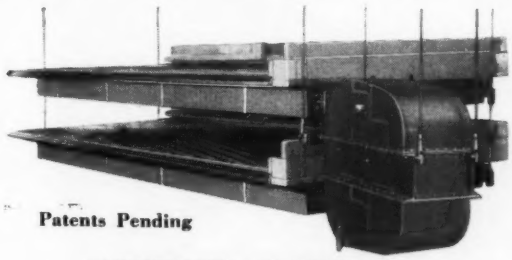
Hebley plans to remain in Pittsburgh and engage in consulting work on problems of air and stream pollution particularly as they concern the coal industry.

Mining Company Changes Countries

Canadian Javelin, Ltd. will shortly become an American corporation to be called the Javelin Corp. The company, which holds mining concessions in South America and Canada, largest of which are in Labrador where its iron ore properties have proven in excess of 2½ billion tons of low grade iron ore, will move its headquarters from St. John's, Newfoundland to New York City.

The main reason for this action according to the company, is that the majority of the company's 12,000 stockholders are Americans.

Recently, Pickands Mather & Co. and a group of American and Canadian steel companies, including Youngstown Sheet and Tube, Interlake Iron Co., and the Steel Co. of Canada, Ltd., announced that they had ordered the construction of a 42-mile railroad to Javelin's Wabush Lake deposit, which they have under lease. This is regarded as the first major step in the development of the Javelin ore bodies.



Patents Pending

CONCENCO® "77" Tables Slash Preparation Cost

The cost of preparing coal in the fine sizes has been slashed dramatically by the CONCENCO "77" table. Twin decks not only double the washing capacity in a given unit of floor space, but do it with very little extra power. The two decks are activated by a single synchronized head motion using exactly the same size motor formerly required for the most efficient single deck table operation.

The economy is obvious . . . but consider also the further economy made possible by eliminating the expense of building expansion when unit capacity needs to be doubled. Even when new housing is required, construction may be lighter, less costly, because the floating "77" DIAGONAL-DECK® tables substantially reduce impact to the building.

For complete information, send for Bulletin 77.

CONCENCO® Feed Distributor

While unexcelled for feeding coal washing tables, the CONCENCO Feed Distributor effectively provides an accurate splitting of feed into any desired number and proportion of parts to feed circuits or machines in battery for their greater overall efficiency. It is a heavily fabricated all steel machine with motor drive requiring 1 h.p. or less in operation.

THE DEISTER ★
CONCENTRATOR
COMPANY
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CONCENCO PRODUCTS

★ *The ORIGINAL Deister Company • Inc. 1906*

1959 AMC COAL SHOW

All Paths Lead to Cleveland May 11-14 As Industry Charts Future Progress

Have you made plans for the Coal Show yet?

If you have, you're in good company. Forward-looking mining men from all segments of the industry have set aside the week of May 11-14 as the time to catch up on the latest in mining technology. With their sights set on increased profits in 1959 and in the years ahead, they realize that the knowledge they pick up at the AMC Coal Show will play an important part in the constant battle to reduce mining costs.

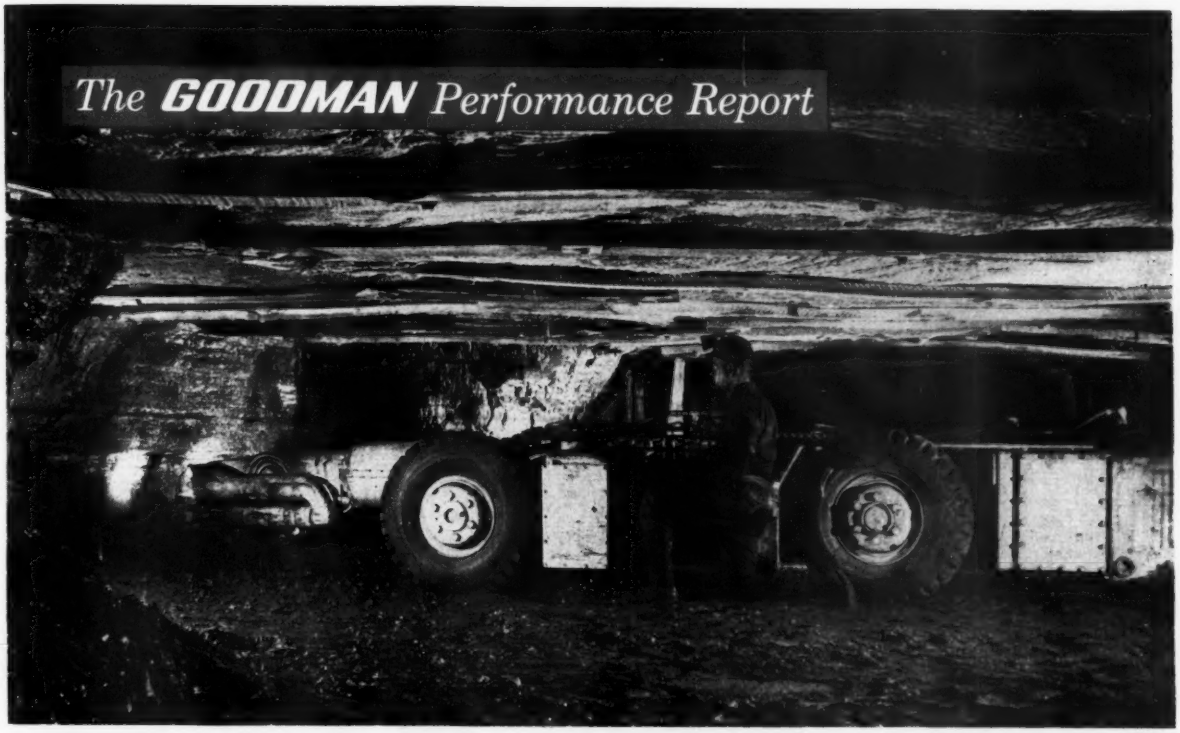
Over 235 manufacturers of mining equipment will be "pulling out all stops" to make the industry aware of the most recent advances in machinery design and their proper application. The range of equipment on display in this giant "showcase" ranges from cotter keys, through $100,000 continuous mining machines, to the largest trucks ever made, and offers an unparalled opportunity to compare competitive pieces of equipment on the spot.

At the many technical sessions, recognized industry leaders will describe experience with new machines and methods in all phases of underground and strip mining, coal preparation and safety. New approaches to old problems will be detailed as industry specialists, including some from abroad, explain the latest concepts in mining technology. A feature of the program will be special sessions for producers of industrial minerals on cost cutting in open pit operations.

On the lighter side, another gala Coal Miners Party has been scheduled for Wednesday evening, May 13, and an outstanding program of social events for the ladies is taking shape. The ladies will also have the fine shops of Cleveland to visit while their men are occupied with business during the day.

Yes, if you haven't yet made plans to come to the 1959 AMC Coal Show in Cleveland, you are missing a big bet. Why not write *now* for accommodations to the Hotel Reservation Bureau, 511 Terminal Tower, Cleveland 13, Ohio.

Your attendance will pay off!



21186

How to cut your cutting costs

It's no problem when you have a Goodman rubber tired machine on the job. Any one of the machines in the 2400 series moves anywhere in the mine. Each has a tramming speed of 210 fpm, and with a 90" wheelbase has full maneuverability even in limited space. There is easy, positive hydraulic control of speed and steering.

At the face a variable speed, hydraulic feed of the cutter arm insures fast cutting. As to cutting range, there are three machines—one 29" high, one 40½" high, and one 42" high—that top, center, bottom cut or shear with no blind spots from top to bottom, or from rib to rib. Then there is a 29" high machine that can be arranged for either top cutting or bottom cutting.

For bottom cutting machines the famous Goodman bugduster automatically controls cuttings, eliminates a dust hazard, leaves a clean kerf.

21871

The Goodman all-purpose cutter has proved a profitable investment in non-metallic mines as well as in coal.

The cutting motor and hydraulic motor on all machines are custom-designed and built by Goodman for either AC or DC operation. Performance is safe and fast. Conveniently located hydraulic controls on both sides of the machine, respond quickly . . . smoothly to your operator's touch.

Strong, rigid end-to-end machine construction with balanced weight distribution makes it easy to "slew" a machine when necessary . . . and there's good road clearance, a life saver for tires.

As for maintenance—a Pennsylvania mine using the Goodman Cutter reports two years of triple shift operation with only negligible attention. Another mine reports no replacement parts needed after 15 months of double shifting. Both were working in pitching seams.

So, to cut your cutting costs, put a Goodman 2400 series to work in your mine. Ask for catalog G-138.

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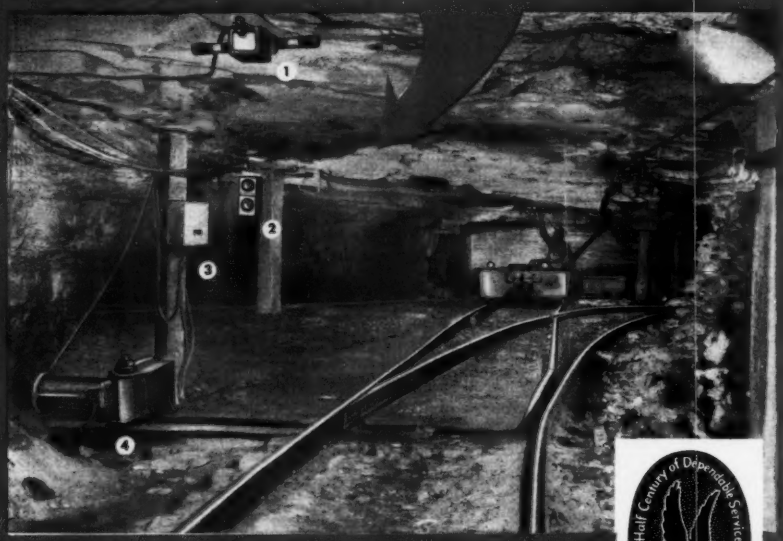
CUTTING MACHINES • CONVEYORS • LOADERS
SHUTTLE CARS • LOCOMOTIVES • CONTINUOUS MINERS

Use Genuine Goodman Replacement Parts

One of 16 Electri-throws INSTALLED AT ISLAND CREEK COAL CO. MINE NO. 25, RAGLAND, W.VA.



A modernization program that eliminates trip riders, for safety and economy—increases size of trips with motors in front and rear—maintains running speeds up to 14 miles per hour—minimizes hazards to personnel.

1. Hand Contactor—for selective service.
2. Light Box—indicates position of switch points.
3. Control Cabinet—houses the contactors, overload relay, and fuses.
4. Canton Electri-Throw — positive for heaviest points—non-centering—houses light switch above casual water. Also available for compressed air operation. Ideal De-railer.

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Rock Dusters, dry and wet — Car Transfers (passers), manual or air operated — Track Cleaners — Ventilating Doors, automatic mechanical or air-powered — Cable Splicers — Terminal Binders — Bond Terminals — Cable Vulcanizers.

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The American Mine Door Co.

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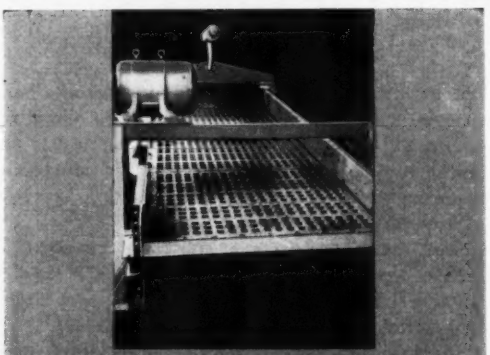

HENDRICK H QUALITY PLATE LASTS ALMOST FOREVER

When economy in your processing operation means the difference between profit and loss—here are four good reasons for you to choose Hendrick H Quality Perforated Plate. This plate is tough and rugged. It's made from high carbon or stainless steels. High carbon can be heat-treated for longer life. Product uniformity is assured throughout the life of the screen. Hendrick H Quality Plate has full openings, to save you costs due to blinding. Deck charges are quick, for lowered labor costs.

Hendrick H Quality Perforated Plate is available either flat, corrugated, or stepped, in any desired shape, and with perforations of any size.

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Perforated Metal • Perforated Metal Screens • Wedge-Slot and Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armogrids • Hendrick Hydro-Dehazer • Distillation Column Internals

(Continued from page 130)

sponding quarter of 1957. Later figures are not available, but it was reported that a barter arrangement had been made with Red China to ship 3500 tons, which was a small consolation after the 1957 sales.

A process for the extraction of rutile from ilmenite has been developed by the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Melbourne. Ilmenite is mixed with pyrite, coke, or coal, and heated in a kiln without air, for 650° to 900° C for about half an hour. This produces porous grains of rutile, globules of sulfur, and iron oxide. Conventional ore dressing methods are used to clean the rutile.

Zircon—The demand for zircon has been fairly strong, principally for foundry sands. The cut back in rutile production in Australia meant that the companies were offering as much zircon as possible and cut the price, which had to be met by the American producers. The present price is about $42 per ton, at Florida mines.

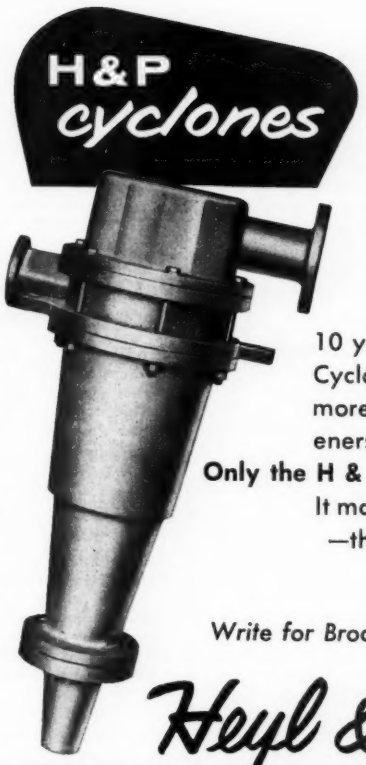
Union Carbide Awards Contract for Ore Dressing Plant

A contract for the construction of a manganese ore dressing plant at Newport News, Va., has been awarded by Union Carbide Ore Co., Division of Union Carbide Corp., to Tidewater Construction Corp. The new plant will be used for processing manganese ore from affiliated mining operations located in British Guiana. Construction will start early this year, with completion scheduled for May 1, 1960. The new plant will grade and classify approximately 30,000 tons of ore a month. Most of the processed manganese ore will be shipped from Newport News by rail to the plants of Union Carbide Metals Co., another division of the corporation, for use in the production of alloys for the Nation's steel mills.

ALSO . . .

More than 1000 producers of coal are being surveyed to obtain essential mobilization planning information. Companies have been asked to supply detailed engineering information concerning the location and description of mining and coal preparation facilities to the Office of Minerals Mobilization. Data will be coded and made available for damage assessment computations by the National Damage Assessment Center of the Office of Civil and Defense Mobilization in case of attack. The data processing operation provides a rapid method for supplying needed information of defense capabilities and assessment damage from bombing and radioactive fallout.

(Continued on following page)



The important figure is

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10 years operating experience proves Cyclones designed with 14° angle are more efficient classifiers and thickeners and thus are more economical.

Only the H & P Cyclones offer this advantage.

It makes good sense to specify the best —the money saving big performer— The H & P Cyclone.

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Joins AMC Staff

Enoch D. Chase, former administrative assistant to Representative James Devereux of Maryland, has joined the staff of the American Mining Congress.

Mr. Chase, an attorney, brings to the Mining Congress many years of experience on Capitol Hill and in industry organization work. A graduate of the Washington College of Law, he engaged in legal practice in the District of Columbia for five years following service as a Naval officer in World War II. He is a member of the District of Columbia and Maryland Bars.

He served as administrative assistant to Representative Devereux for five years, and had previously served on the staff of Representative Charles Brownson of Indiana. His work on Capitol Hill included legislative research, public relations, and continuous contact with Congressional committees and with the administrative agencies and departments of the Federal Government.

Prior to his legislative work he was for five years assistant secretary of the National Industrial Traffic League, a trade organization devoted to transportation problems.

The new member of the Mining Congress staff had a distinguished naval career during World War II, serving in the Naval Intelligence, both overseas in the European Theater, and in the office of the Secretary of the Navy.

(Continued from previous page)

A New York insurance company has canceled all its policies protecting Pittsburgh, Pa., district home owners against loss from damage resulting from surface subsidence caused by coal mining operations. The policies, about 50 in all, were offered for the first time in June 1958 by Citizens Casualty Co. of New York. The company reportedly decided to cancel—and pay back home owners for "unused" portions of the premiums on a prorated basis—because of the small number of policies issued. The action marks a setback—if not the death—of the first program of insurance coverage against damage from mine subsidence.

The Atomic Energy Commission is looking into the possibility that abandoned salt mines might be good places to dump radioactive waste. The AEC reported it is negotiating for tests in Kansas. Waste materials would be simulated, with no radioactivity involved, so there will be no radiation hazard. Experiments will be directed by the Commission's Oak Ridge, Tenn., national laboratory, which has held preliminary discussion with Carey Salt Co. of Hutchinson, Kans. The AEC is considering using part of Carey's Hutchinson mine, which is not now used for salt production.

Peabody Coal Co. has purchased the Black Star Coal Corp. properties at Alva, Ky. The Alva mine, a deep operation, is presently producing about 500,000 tons of coal annually. Peabody will operate it under the name of Alva Coal Corp. Black Star will act as a sales agency for the output as well as for other eastern and western Kentucky coal firms.

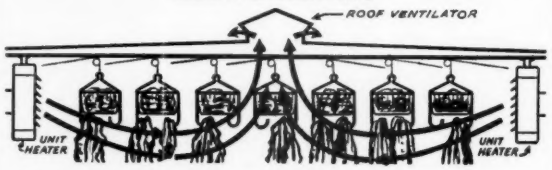
Allis-Chalmers Manufacturing Co. was the lowest of three U. S. companies bidding on generators to be installed at Wilson Dam near Sheffield, Ala., but three foreign manufacturers bid lower than the American companies. Tennessee Valley Authority engineers have approved the $2,639,000 bid of Brown-Boveri & Co., Ltd., of Switzerland, and the authority's purchasing department has recommended that the board accept it. Allis-Chalmers' bid was $4,290,180.

An explosive charge which shot through a fresh fall of coal in another entry and ignited recently-liberated gas caused the October 27 mine disaster in McDowell County, W. Va., in which 22 men died. That was the conclusion reached in a State Mines Department investigation into the blast in the Bishop No. 35 mine of Pocahontas Fuel Co.

Powdered slag containing three percent uranium is now offered for sale by the U. S. Atomic Energy Commission to properly licensed persons. The magnesium fluoride slag is a by-product of the AEC's normal uranium metal production. The charge is $26.00 per kilogram ($11.82 per lb) of contained uranium, f. o. b. Weldon Springs, Mo.

Robert H. Hughes, president of Clinchfield Coal Co., will head the new operation of former Elk River Coal & Lumber Co. interests in Clay County, Va. Clinchfield is affiliated with Pittston Co. of New York City which recently purchased the stock of Elk River. Current plans call for an exploration of 80,000 acres involved in the purchase to determine coal reserves.

OVERHEAD CLOTHING STORAGE
WITH
MOORE LOCKERBASKETS
SELF-VENTILATING



With Moore Lockerbaskets, clean warm air from unit heaters is blown over clothes and exhausted through roof ventilators, removing all odors and leaving clothes fresh and dry.

100% EXPOSURE TO AIR AND LIGHT
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SPACIOUS, OPEN ROOM AREA

Overhead Lockerbaskets leave the floor unobstructed, reduce size of locker room by one-half. Open floor areas eliminate congestion and crowding, suggest spaciousness and reflect cleanliness. Advanced change room design calls for overhead storage.

Send for your free changeroom survey and lockerbasket layout sheet. Address

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CHIEF RESEARCH ENGINEER, for coordinating research on ore beneficiation. Must have diversified experience with techniques used in mineral preparation. Both research and operating experience desirable. Assignment will include the initiation of broad research programs, follow-up of these programs to detailed engineering, and advice to top management on problems related to these programs. Location — Western Pennsylvania. Ten to fifteen years' experience desirable. Starting salary commensurate with qualifications. Reply Box No. 259.

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NEWS and views

Huge Truck Hauling Copper Ore

The world's largest truck recently went into operation in the world's largest copper mine. A 750-hp, 165-ton, rear dump truck recently started hauling waste material in the Bingham open pit mine of Kennecott Copper Corp. The vehicle stands 14 ft high, is 15½ ft wide and 55 ft long. Two supercharged 375-hp engines drive it. It is capable of hauling 110 cu yd of material in a single trip, and with a special hydraulic hoist mechanism, can dump its load in 15 to 18 seconds.

When carrying a full load, the big truck tips the scales at about 240 tons—provided there are any scales big enough to weigh it. Owners of the vehicle, Western Contracting Corp., of Sioux City, Iowa, built the truck. It was first used on a dam construction job on the Missouri River and proved so successful it was shipped to Utah on a railroad car for trial at the copper mine.

New Alumina Refinery in Texas

Aluminum Company of America recently started operations at its newest and largest alumina refining plant. The new Point Comfort, Texas, plant is still incomplete, and will remain under construction throughout most of 1959. However, sufficient equipment has been installed to begin shakedown operations.

When the new plant is in full operation, it will have an annual capacity of 1,000,000 tons and will provide jobs for more than 600 people. The operation's ultimate cost will be in excess of $45,000,000, and the plant is so designed as to make possible a future doubling of its capacity.

The refining operation is equipped to process two distinct types of bauxite ore—one from Surinam, S. A., and the other from new Alcoa mining operations in the Dominican Republic.

The first shiploads of bauxite were of South American origin and arrived at Alcoa's new Aransas Pass transfer station, near the Gulf fishing resort of Port Aransas, about the middle of January. The ore was then transshipped by barge 70 miles through the Intracoastal Canal and the shallow waters of Matagorda Bay, to the new refining plant at Point Comfort. The Aransas Pass transfer operation is a temporary expediency, to be continued only until completion of the deepwater Matagorda Bay Ship Channel, authorized by Congress this year.

Wyoming's First Acid Plant

Wyoming's first sulphuric acid manufacturing plant to produce acid for sale to industry has started operations. The $750,000 plant, owned by Fremont Minerals, Inc., is located at Riverton. Rated at a capacity of 100 tpd, it will supply acid to oil refineries, ore processors, the sugar industry and fertilizer manufacturers.

The plant is utilizing the "contact" process which produces acid through the burning of pure sulphur and reduction of the resulting gases. Sulphur for the plant is obtained from local Wyoming suppliers who recover it from sour natural gas. The practically pure sulphur thus obtained contributes to a high quality acid product. The plant will be operated by the Chemical Division of Fremont Minerals.

Safety Awards Go To CF & I

The impressive achievement of working nearly 8,000,000 man-hr without a fatality has brought national recognition to some 2500 miners of The Colorado Fuel & Iron Corp. In ceremonies held recently, officials of the Health and Safety Department, U. S. Bureau of Mines, presented Joseph A. Holmes Award and Honor Certificates to the company's Mining Department and to employes and management at three mine sites in Colorado and Wyoming.

Singled out for individual mention was Robert J. Crocfer, assistant mine foreman at the Frederick coal mine, Valdez, Colo. Crocfer received a certificate for his supervision of a crew of 40 miners who worked 268,000 man-hr between October 1, 1953 and March 1, 1958, without a single lost-time accident. Another Certificate of Honor was awarded to the employes and management of the same mine, where an average of 600 miners set a record by working 1,425,768 man-hr without a fatality from September 6, 1956 to March 1, 1958.

A Holmes Certificate was won by the Allen coal mine, near Weston, Colo., where an average of 550 miners worked 3,060,269 man-hr without a fatality. During this period, from December 23, 1953 to March 1, 1958, production amounted to 2,276,637 tons of coal.

Operating with the same high degree of safety, although at a different type of mine, employes of the Sunrise iron ore mine, Sunrise, Wyo., received a certificate for 3,456,151 man-hr without a fatality for the period of July 15, 1951, through March 1, 1958, while producing 4,422,284 tons of iron ore.

In awarding a Certificate of Honor to the Mining Department, the USBM took special note of the substantial reduction of injury rates throughout all of the company's mines and quarries over the past 11 years.

ALSO . . .

Potash companies in the Carlsbad, N. M., area report that they are unable to get adequate insurance in the face of a proposed underground nuclear explosion scheduled to be fired next August in the salt beds about 25 miles southeast of Carlsbad. The companies previously protested that the proposed location for "Project Gnome" is too close to the potash mines and recommended an alternate location.

In operation a little over a year, the American Gilsonite Company's plant just west of Fruita, Colo., is planning a $450,000 expansion program. AGC's gilsonite processing will be increased from 700 to 850 tpd. The company has another gilsonite mine at Bonanza, Utah, and produces about 1300 bbl of gasoline, 300 bbl of fuel oil and 250 tons of calcined coke per day.

In the largest underground mine in the United States, over 70% of the daily production of 28,000 tons of molybdenum ores — more than half of all the moly this side of the iron curtain — is hauled in Card Granby type cars built to Climax specifications.

These are the largest and heaviest cars of this type we have built . . . designed to withstand unusually rugged loading conditions plus the wear and tear inflicted by a cleanout machine (also a Card product).

CARD car engineering results in large savings to many of the major ore producers of the world with cars built to special order at little more than the cost of standard stock models. CARD engineers are happy to consult on any haulage problem. No obligation.

C.S. Card Iron Works Co.

2501 WEST 16th AVE.,
DENVER, COLORADO

The slag dump and 31 acres of ground at the site of the old lead smelter of American Smelting and Refining Co. in Murray, Utah, has been acquired by International Smelting & Refining Co. The dump contains a considerable amount of slag having a zinc content of from four to seven percent. Company officials said that current low metal prices do not justify present processing of the slag, but a limited tonnage is being treated to gain experimental and operating data.

The Jack Pine phosphate lease in the Elliston, Mont., phosphate field has been purchased by The Bunker Hill Co. The property is located about 200 miles east of Kellogg, and just west of the Continental Divide, about 30 miles from Helena. The company plans to manufacture phosphoric acid and fertilizer in a new plant which will be completed in 1960.

The largest producer of salt on the Pacific Coast, Leslie Salt Co., has purchased Deseret Salt Co., of Salt Lake City. The harvesting ponds and processing equipment of the solar-evaporation salt operation are about 25 miles southwest of Salt Lake. Leslie's new Utah Division plans considerable renovation of the operation, and continued sale of commercial and industrial grade salt.

Guest speaker at the Northwest Mining Association's 64th Annual Convention in Spokane was Royce A. Hardy, Assistant Secretary of the Interior. Hardy outlined the work of the Administration in promoting a more healthy mining industry, and proposed three lines of action to preserve the strength of the industry: (1) greatly increased exploration; (2) accelerated research, and (3) cooperation among the minerals producing nations to solve their mutual problems.

Headquarters of the Strategic Minerals Division of Phillips Petroleum Co. has been transferred from Salt Lake City to Bartlesville, Okla. The division has been largely concerned with the development of uranium deposits in the West.

Discovery of a large magnetite deposit in southwestern Montana has Canadian and French industrialists interested. Latest speculation concerns the possibility of a steel mill built in the Crows Nest Pass bituminous coalfield, 80 miles west of Lethbridge, Alta., which would use the Montana ore. Several interested businessmen visited the area, near Dillon, Mont., last October and investigated the ore claims. The deposit is reported to contain material analyzing 30 percent or more iron.

Expendable pallets for shipping sacked cement have been introduced by Calaveras Cement Co. The new development will increase freight savings and payload by eliminating more than half a ton of wooden-pallet dead weight on every standard flat-bed haul. Developed by the San Francisco company's own staff, the new pallets weigh five lb and are made of wood-reinforced corrugated cardboard. Pallets are designed to carry 31 to 36 sacks of cement each.

Dow Chemical Co. and U. S. Borax Research Corp., a wholly-owned subsidiary of United States Borax & Chemical Corp., have announced their agreement to engage in a joint venture to perfect an economic process for the manufacture of boron trichloride. The research program will be conducted at Dow's Texas Division in Freeport, Texas. The joint project comes as a climax to several years of independent research in this field which both Dow and U. S. Borax Research have been conducting.

A novel suspended-cage method of driving a vertical raise is described in USBM Information Circular 7868. A hexagonal work cage was built to accommodate two men and their equipment. An adjustable cover protected them while they barred down loose rock overhead and was used as a working platform for drilling and loading.

A 622-ft, six-ft diam raise was completed in record time and at a lower cost than would have been possible with conventional methods. The project, near Leadville, Colo., was a joint undertaking of Resurrection Mining Co. and American Smelting and Refining Co.

Work is being continued by Delhi-Taylor Oil Corp. toward establishment of a multimillion dollar potash mine and plant at Cane Creek, south of Moab, Utah.

A training course on radioactivity was recently started at The Anaconda Company's uranium mill site at Grants, N. M., under the sponsorship of the New Mexico Department of Public Health. General topics discussed included processes of radioactive growth and decay, detection and measurement of radiation, biological effects of radiation, and fundamentals of mine ventilation and their application to the control of radon gas.

Kennecott's copper production in Utah became fully integrated the first of the year when the world's largest copper smelter which is located west of Magna, became part of the Utah Copper Division of Kennecott Copper Corp. Owned and operated by American Smelting and Refining Co. since it was built in 1906, the smelter was purchased by Kennecott in 1958. It has an annual capacity of 625,000 tons of concentrates.

The Utah Copper Division operation now includes the open-pit mine at Bingham Canyon, and the two ore concentrating mills and the electrolytic refinery at Magna, in addition to the smelter.

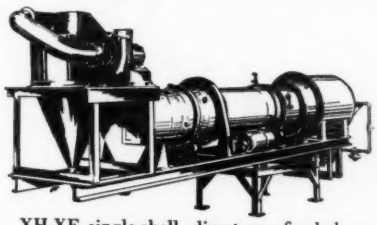
There will be no change in ownership of Garfield Chemical and Manufacturing Corp., a large producer of sulfuric acid from smelter gases. Asarco and Kennecott will retain 50 percent of the capital stock of this corporation.

Rising freight rates have prompted Inland Steel Co. to acquire its first distribution outlet in the Southwest. Inland is acquiring Vinson Steel & Aluminum Co., a large Dallas steel warehousing and marketing firm.

A blending and processing plant for manganese ore at Wenden, Ariz., has been started by Giant Resources, Inc., of Grand Junction. End product of the activity is a metallurgical grade of manganese which is sold directly to the GSA for the Government stockpile.

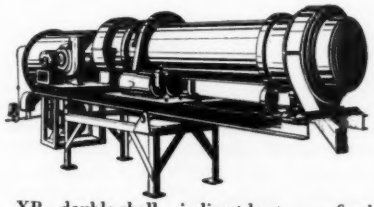
PILOT PLANT ROTARY DRYER

The Ruggles-Coles Pilot Plant Dryer is designed especially for laboratory use or for small capacity unit operations requiring a continuous or intermittent drying step. Available in three models.

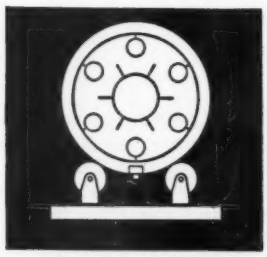


XH-XF single-shell, direct gas fired dryer. Arranged for either parallel or counter-flow operation. Bulletin AH-471-52.

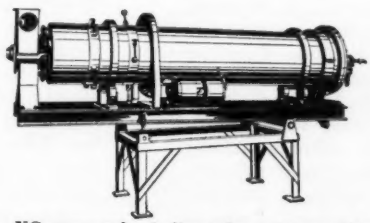
XH-XF SINGLE-SHELL



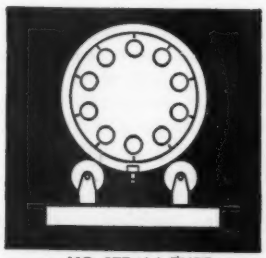
XB double-shell, indirect-heat, gas-fired dryer for drying without contamination. Volatiles removed with only limited dilution. Bulletin AH-472-52.



XB DOUBLE-SHELL



XC steam-tube indirect heat dryer. Can be connected to any available steam supply or furnished with a 3-HP steam generator. Bulletin AH-473-52.



XC STEAM TUBE

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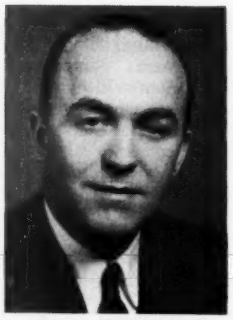
R. E. SALVATI
AMC President

CRIS DOBBINS
Western Division Chairman

C. H. STEELE
Program Committee Chairman



W. L. WEARLY
Manufacturers' Division Chairman

AMC MINING CONVENTION

Scheduled for Denver, September 14 to 17

CRIS DOBBINS, president of Ideal Cement Co. and chairman of the Western Division of the American Mining Congress, has named many of the mining men and ladies who will assist in developing plans for the 1959 Metal Mining and Industrial Minerals Convention to be held in Denver, September 14 to 17.

Chester H. Steele, vice president of Western Operations, The Anaconda Co. has accepted the chairmanship of the Program Committee. Leading mining men, representing all producing areas of the country, will work with Steele to develop the convention sessions. The program will feature an interchange of views between representatives of the mining industry, top government officials and members of Congress on national policies affecting mineral and metal production. Federal programs, legislation and administrative action needed to strengthen domestic mining will be considered, and the results of Convention deliberations will be set forth in a Declaration of Policy by the industry.

Sharing the spotlight will be a full airing of the latest developments in operating methods and equipment in all phases of metal mining and industrial minerals production.

To assist him in making Convention arrangements, Dobbins has appointed Albert E. Seep, president, Mine and Smelter Supply Co. as vice chairman of the general committee.. Gerould A. Sabin, director of advertising, Colorado Fuel & Iron Corp., is chairman of the Publicity Committee, and J. Price Briscoe, chairman, Clear Creek County Mining Association, heads the Trips Committee. Ben C. Essig of Denver will be in charge of the Welcoming functions.

Mrs. W. T. Ahlborg is chairman of the Ladies Hospitality Committee and will be assisted by an advisory group including the wives of several other distinguished mining men: Mrs. Frank Coolbaugh of Golden, Mrs. Howard Crandell of Denver, Mrs. Cris Dobbins of Denver, Mrs. Ben C. Essig of Denver, Mrs. Albert E. Seep of Denver, and Mrs. Merrill E. Shoup of Colorado Springs.

Many others, prominent in the mineral industry, will assist these committee heads in lining up all phases of this most important mining Convention of the year—to make sure that it will be completely enjoyable and worthwhile.

Hotel reservations will again be handled by a Housing Committee, and reservation blanks have already been mailed out to the industry. Reservations may also be requested directly by letter to the AMC Housing Bureau, Denver Convention and Visitors Bureau, 225 West Colfax Ave., Denver, Colo.

A few more uranium tidbits. The AEC has issued an allocation of ore reserves to Quinta Corp. which could lead to mining and milling of the company's deposit in the Grants, N. M., area. . . . The government will close its uranium processing mill at Monticello, Utah, about the middle of 1959. . . . Columbia Southern Chemical Co. has started development work at Palangama Dome north of Benavides, Tex. . . . Lakeview Mining Company's new 210 tpd, $6,500,000 uranium reduction plant has started operations. . . . Pilot plant tests on a supersonic separation process for treatment of low-grade uranium ores are being conducted by a Los Angeles company under contract with Hidden Splendor Mining Co. If the process proves feasible it may be a boon to the mining companies with low grade deposits near Spokane and elsewhere. . . . Another process for treating low-grade uranium ores is being tested by Eljo Oil and Mining Corp., of Las Vegas. Laboratory tests have produced a concentrate of 85 percent U_3O_8 from Utah samples which analyzed 20 percent lime and only 0.08 to 0.13 percent U_3O_8. A pilot plant is being set up to double check this process.

WHAT ARE YOUR RESERVES?

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LET US HELP YOU FIND OUT

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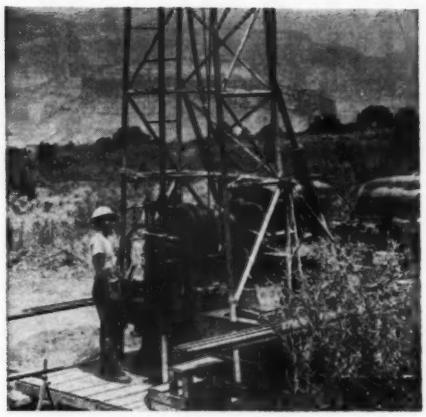

Coal in Kentucky . . . Uranium on the Colorado plateau . . . Bauxite in the Ozarks . . . Limestone in Pennsylvania . . . Copper in Montana . . . These are but a few examples of the extent of our operations. Throughout the United States and even in many foreign countries we have successfully explored and proved ore reserves for our many customers, and where normal methods have failed, special techniques have been developed. In the Gas Hills Area of Wyoming, for example, we successfully cored the loose sand and siltstone where others had failed by "freezing" the material. Our personnel and equipment are stationed throughout the United States awaiting your call.

SPRAGUE & HENWOOD, Inc.
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New York—Philadelphia—Atlanta—Pittsburgh—Grand Junction, Colo.—Buchans, N.F.

WHEELS OF GOVERNMENT

(Continued from page 133)

The subject of such claims has been before Congress in years gone by but has never reached the hearing stage. It is understood that the study being made by the Senate committee staff may result shortly in a bill being introduced and hearings being held. There appears to be more than usual interest in such a bill this year, and some form of action may be taken by the Senate Interior Committee should public hearings demonstrate strong support for such a move.

COAL INDUSTRY GETS DEFENSE SURVEY

More than 1000 companies engaged in the mining and processing of bituminous coal and lignite are being surveyed to obtain essential defense mobilization planning information concerning their facilities. The Interior Department announced that its Office of Minerals Mobilization is conducting the survey, data from which will be coded and made available for damage assessment computations by the Office of Civil and Defense Mobilization.

COMMISSION HOLDS IRON ORE HEARING

The Tariff Commission held a one-day hearing in Washington last month in connection with its current investigation of conditions of competition in the United States between iron ore produced in the United States and in foreign countries. The study, begun in August, was requested by the Senate Finance Committee.

Spokesmen for domestic iron ore and steel companies pointed out that continued development of new sources of iron ore both in the United States and abroad, particularly the Western Hemisphere, is essential to the welfare of the steel industry and to the U. S. economy as a whole.

The Commission was told that modern methods of beneficiating low-grade iron ores in the Lake Superior region are resulting in increased shipments of ore from that area, but that future development of domestic sources requires favorable political and economic conditions, including favorable depletion, depreciation and taxing policies by both the Federal and State governments.

It was emphasized that the requirements of the iron and steel industry for an adequate supply of ore, at costs which will permit the industry to compete at home and abroad with foreign steel products, demand no governmental interference with the industry's ability to use the most economic sources of ore supply.

A representative of the United Steelworkers of America testified that unemployment in the domestic iron ore industry resulted from the business depression, not from imports of iron ore.

MINERAL EXPLORATION LOAN RULES ISSUED

Regulations under which the Government will give financial assistance to qualified companies and individuals in mineral exploration projects have been issued by the Department of the Interior. The financial-aid program, authorized by Congress last year, will be administered by the Department's Office of Minerals Exploration.

Under the regulations, the OME may advance funds covering up to 50 percent of the allowable costs of an exploration project, but the Government's share in any one contract may not exceed $250,000. The Government funds are repaid, with interest, from any production resulting from the project.

OME participation in the search for these 32 minerals is authorized: antimony, asbestos, bauxite, beryl, cadmium, chromite, cobalt, columbium, copper, corundum, industrial diamonds, fluorspar, crucible flake graphite, strategic kyanite, lead, manganese, mercury, strategic mica, molybdenum, monazite, nickel, platinum group metals, quartz crystal, rare earths, rutile-brookite, selenium, block steatite talc, tantalum, thorium, tin, uranium, and zinc.

To be eligible for Government aid, an applicant must furnish evidence that funds for exploration are not available from commercial sources on reasonable terms.

"READY-TO-USE" DYNATEX* COSTS LESS THAN PRILLS

Extensive tests conducted in open-pit mines and quarries have shown that Dynatex produces rock or ore at a lower cost than prilled ammonium nitrate-fuel oil mixtures.

These tests, conducted under actual working conditions, proved that Dynatex permitted an increase in the distance between drill holes as well as an increased burden. Economies were effected all along the line. The explosives loading factor was reduced, as were loading time, labor, drilling, and blasting costs.

If you have, or are now using, a prilled ammonium nitrate-fuel oil mixture, be sure to test Dynatex on your next blast. Our technical representatives will be glad to show you how Dynatex blasting agent can cut your costs, too. Phone or write our nearest branch office for complete information.

NO FUSS—NO MUSS. No mixing on the job—Dynatex is delivered ready for use.

QUICK LOADING. In cartridges, Dynatex is quickly loaded into bore holes. Where conditions permit, Dynatex may be poured into bore holes.

UNIFORM STRENGTH AND QUALITY. Dynatex is a blasting agent of uniform known strength and dependability.

CHOICE OF PACKING. Dynatex is available in multiwall paper, special burlap or Flexo-Bag® containers, or in fiber drums of standard diameters.

*Hercules trademark

Explosives Department
HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington, Delaware

XR59-1

Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazleton, Pa.; Joplin, Mo.; Los Angeles, Calif.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Calif.

HERCULES

manufacturers forum

Loader

THE REAR-WHEEL-DRIVE, front-wheel steer Model H-30R "Payloader" has a carrying capacity of 3000 lb at average operating speeds. Buckets from two-thirds to two cu yd are offered for the handling of various materials within the rated capacity. The Payloader has a torque-converter with a 2.6 to 1 stall ratio and a four-speed, full-reversing, manually-shifted transmission. It is powered by a six-cylinder Hercules gasoline engine developing 66.5 hp at 2200 rpm. Numerous attachments are available for the H-30R. Complete specifications and data may be obtained by writing Frank G. Hough Co., 846 Seventh Ave., Libertyville, Ill.

Cutter Bits

FOR CONTINUOUS MINING MACHINES, two cutter bits have been announced by Austin Powder Co., Cleveland 13, Ohio. Known as AP-10 end mill type and AP-10D plug type, they are said to provide maximum service life even under severe cutting conditions. This is achieved by reportedly virtually eliminating the major causes of bit failure—tip loss and shank breakage. Design of the tip area on each model features a large surface for brazing of the carbide insert. Efficient tool performance is said to be further assured by use of special alloy steel shanks.

Reflective Utility Markers

FOR POSITIVE IDENTIFICATION IN MINES and mining areas, Westline Products offers a line of Reflective Utility Markers that are available in numerals and letters. Markers are said to be 100 times more reflective than white or yellow stencilled paint, and can be used to quickly make up warning, instruction, safety, directional or special wordings. For free sample and location of local source write Westline Products Division of Western Lithograph Co., 666 East 2nd St., Los Angeles 54, Calif.

Machine Processes and Dries Microfilm

A SELF-CONTAINED UNIT which processes and dries microfilm at the rate of 100 ft of film in 30 min. has been announced. Unipro (universal processor) will process 16mm, 35mm or 70mm film continuously or interchangeably without adjustment and without special attachments. The machine is made for daylight loading and operations. Specifications and additional information are available by writing Remington Rand Division of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y., and asking for F-533.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Scraper

A SELF-PROPELLED, two-axle scraper has been added to its line of high speed earthmoving equipment, according to South Bend Division, Curtiss-Wright Corp., South Bend, Ind. The CW-220 is rated at 20 cu yd struck and 27 cu yd heaped, and is powered by a 375 hp, GM 6-110T diesel through an Allison torque converter and automatic transmission with four forward and two reverse speeds. This unit has the added advantage of being interchangeable with a 35-ton rear dump utilizing a Torqmatic brake for hydraulic retarding and control on steep grades.

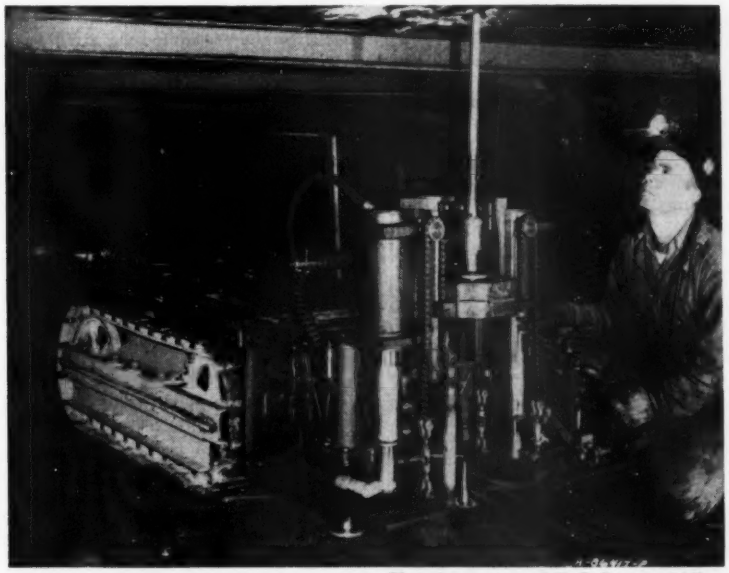


Photo by courtesy of U. S. Bureau of Mines

Bolting Machine Has Dust Collecting System

A HYDRAULIC ROOF DRILL machine for coal mines mounted on crawlers and incorporating a dust collecting system has been announced by Schroeder Brothers Corp., McKees Rocks, Pa. Approved by U. S. Bureau of Mines and called RoofCat, the machine is maneuvered by dual controls that operate the crawlers in unison or independently. Tramming speed may be varied from an inching crawl up to 175 fpm. The Cat's hydraulic system is protected by a micronic return line filter built into the tank.

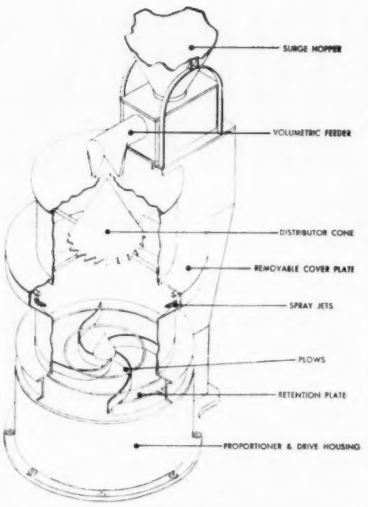
Two approved dust collecting systems are available for the RoofCat—the vacuum cup or the "thru-steel" type. In the "thru-steel" system, dust is sucked into the opening of the hollow steel as the bit penetrates the roof and is carried through heavy rubber tubing to a dust collector at the rear of the machine.

The RoofCat is 23-in. high, 36-in. wide and 102-in. long. It has an operating feed length from 22 in. up, depending on roof height. Hydraulic stabilizing jacks are standard equipment, and a riding platform is furnished if desired.

Blender for Dry or Liquid-Dry Mixtures

A CONTINUOUS-FLOW blender has been developed that reportedly accurately proportions, mixes, blends and discharges a wide range of dry materials, or blends liquids with solids in precise quantities. The blender, called Verticone, can be used in a wide variety of applications in the mining industry, such as the control of dust created by the unloading or discharging of coal or metal ores from bins and silos. According to the manufacturer, dry materials are rendered dust-free for further handling or processing. Treatment also suppresses the dust from the unloading of collection bins of cyclones, bag filters, or electrostatic precipitators on smelters, furnaces, dryers, roasters and kilns, for dust-free disposal by truck or rail, or return to process.

Materials to be treated or blended are fed proportionately into the Verticone via controlled volumetric feeding equipment onto the apex of a cone. This cone is the first step in blending of solids as it causes the material to form a circular, falling curtain as it leaves the base periphery of the cone. At the base of the cone, spray headers can be provided to disperse any desired liquid into the mixture in any proportions required. Liquid is sprayed on the blended dry material from both inside and outside the curtain as it falls onto a retention plate. Further blending of both the solids and liquids



is made on the retention plate by mixing blades that automatically discharge the completely blended and treated material.

In applications where only solids are blended, dust control can be provided by conditioning with Compound MR solution, a surface active compound developed by the manufacturer to keep the fine particles evenly dispersed to prevent segregation in the mix and eliminate dust.

For further information contact Johnson-March Corp., Dust Control Engineers, 1724 Chestnut St., Philadelphia 3, Pa.

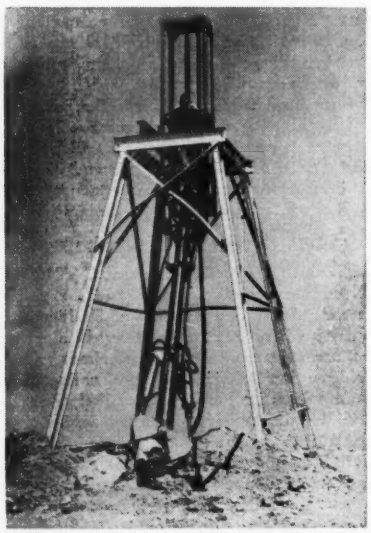
Sheave

A STATIONARY CONTROL ADJUSTABLE SPEED sheave—the Adjustex sheave—has been introduced by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. The sheave is available for A, B and C section belts in two, three and four-groove construction. Pitch diameter sizes parallel the former Vari-Pitch sheaves. One entirely new diameter for C section belts—7.5/9.7 in. pitch diameter—is available for higher speed and wider speed range applications. Design capacities to 75 hp are covered by 33 sizes.

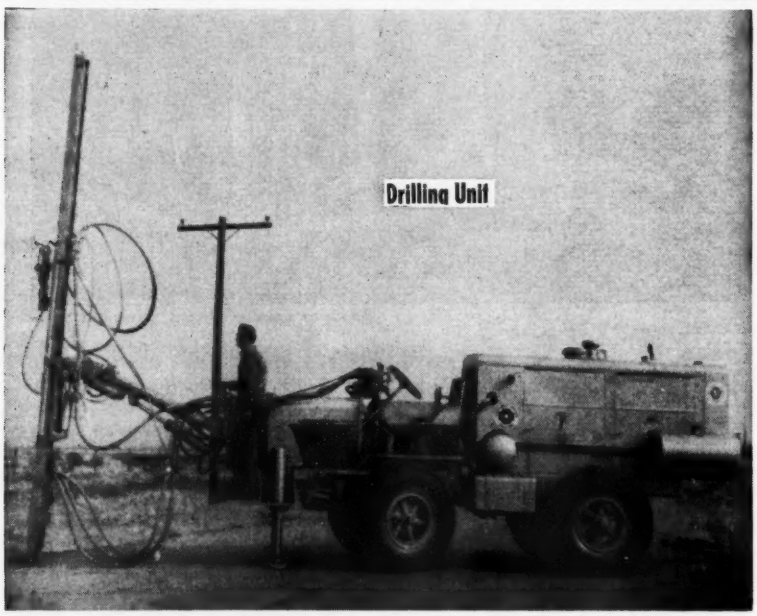
According to the manufacturer, a new concept of pitch diameter adjustment is featured in this sheave. Patented interdigitated lug disc design is retained. Adjustment is made through an adjusting screw and a hollow lock screw. Relative position between stationary and movable discs reportedly is positively maintained at all pitch diameters without disc to main sleeve set screws.

Shaft Mucker

A SMALL VERSION of the Cryderman Shaft Mucker manufactured by Shaft & Development Machines, Inc., Salt Lake City, Utah, the Betsy model is designed to operate in circular shafts with diameters from 6 to 10



ft and in compartment shafts from 4 by 7 ft to 14 by 7 ft. The machine is operated by an air cylinder mechanism that reportedly provides complete flexibility of boom movement, opens and closes clam jaws and applies positive pressure at point of digging. The boom can be moved 12 ft forward, 6 ft back and 12 ft to either side of vertical. The safety cage mounted at top of boom houses the operator, controls and hoist. Boom length is 13 ft, 3 in. from center of the gimbal to bottom of bucket. Boom extension is 8 ft, over-all length 24 ft 9 in.



A RUBBER-TIRED drilling unit has been developed by Four Wheel Drive Auto Co., Clintonville, Wis., in conjunction with Gardner-Denver Corp. of Quincy, Ill. The carrier is an FWD Model BX, rubber-tired tractor. The drill equipment and compressor is manufactured by Gardner-Denver. The compressor is a 365 cfm rotary powered by a 4-71 GMC diesel. Chain feed and drill are all controlled by a hydraulic system.

Drawing Reproduction System

A SYSTEM FOR REDUCING and enlarging original drawings, Retrievable Miniaturization reportedly provides reduced-size intermediates that capture all information on the original drawing and provides enlargements showing all details clearly. This line of revolute equipment includes a continuous flow-type camera with an optical system to produce various ratios of reduction, an enlarger for making blowbacks, and automatic processors. Material being copied may be up to 42-in. wide by any length, and may be processed at speeds up to 30 fpm. Reduced-sized copy may be produced on many sensitized materials such as film, plastic, paper, card stock, vellum or cloth. Blowbacks may be made on the same materials. Additional information is available from **Paragon-Revolute Corp.**, 77 South Ave., Rochester 4, N. Y.

Crusher

ADVANTAGES OF A ROLL CRUSHER and a hammer mill are said to have been combined in the Rollhammer. The machine crushes practically any material with a minimum of undesirable fines and is particularly adaptable to materials that have a tendency to build up, according to O'Brien Industrial Equipment Co., 1569 Hudson Ave., San Francisco 24, Calif. The unit can be adjusted to produce any size down to six mesh when used in closed circuit. Hammer and roll are independently driven at different speeds, and the crusher can be furnished rubber lined.

SOLID FILM LUBRICANT. *Electrofilm Technical Service, P. O. Box 106, North Hollywood, Calif.* Technical Bulletin No. 2056 describes a solid film lubricant which contains small particles of lead, tin and graphite which are well-known for their ability as bearing materials. The semi-porous nature of No. 4856 is said to absorb oil and act as a reservoir against metal to metal contact under high loads, and especially during long shutdown periods. Typical applications include spherical bearings, clutch assemblies, leather oil seals, spline assemblies, bearing cages, sleeve bearings, piston cylinders, valve stems and hydraulic actuator parts.

STAINLESS TUBING, PIPE AND WELDING FITTINGS. *Tubular Products Division, Babcock & Wilcox Co., Beaver Falls, Pa.* Engineers, purchasing agents and others responsible for the procurement of stainless tubing, pipe and welding fittings will be interested in the technical data card TDC-189. This card tells of the high temperature properties of B&W Croloy 16-13-3 (TP 316), its chemical composition, size ranges, and short time tensile and rupture properties.

DIGITAL CLOCK. *Panellit, Inc., 7401 No. Hamlin Ave., Skokie, Ill.* Bulletin No. 8-41 illustrates and gives technical details on universal digital clock with three independent outputs each resolved to one second.

—*Announcements*—

Jack H. How, president of **Western Machinery Co.** and **Western Knapp Engineering Co.**, has been elected president of the San Francisco Chamber of Commerce for 1959.

Sprague & Henwood, Inc., has announced the formation of a new, wholly-owned subsidiary, **Sprague & Henwood International Corp.** The new subsidiary will handle all export business of Sprague & Henwood, a leading manufacturer of diamond drills, diamond bits, drilling and sampling equipment as well as a widely known drilling contractor.

P. H. Mulcahy has been named general manager of **Wemco**, a division of the **Western Machinery Co.**

Kenneth D. Schreyer has been named sales manager, Mining Equipment Division, **Columbus McKinnon Chain Corp.**

Abe Goldberg, associated with **Allis-Chalmers Mfg. Co.** processing machinery department for the last 55 years, has retired. **David L. F. Wilson** has been appointed engineer-in-charge of renewal parts in Allis-Chalmers processing machinery department.

David W. Houston has been named assistant sales manager of **Fairmont Machinery Co.**, Fairmont, W. Va., manufacturer of coal preparation plants and processing equipment for the mining industry.

D. W. Houston

J. Cosgrove

John Cosgrove has been named as district sales manager for **Goodman Mfg. Co.** at Huntington, W. Va.

The corporate name of **Cardox Corp.** has been changed to **Airdox Cardox Products Co.**, with general offices in Chicago. The following have been named officers of the company: **David M. Klausmeyer**, president; **Clarence H. Caughey**, executive vice president and general manager; **Paul C. Manley**, vice president in charge of sales for mining activities; **Richard J. Bailey**, general manager, high pressure pneumatics division; **John C. Ross**, comptroller and treasurer; **William P. Nottingham**, secretary. Caughey will also serve as president of the **Tung-Set Corp.**, an affiliate of Airdox Cardox that manufactures carbide tools for mining. Manley will be vice president and **William P. Nottingham**, secretary.

CATALOGS & BULLETINS

LIFT TRUCK *Engine-Material Handling Division, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.* Engineering, design and construction of the Allis-Chalmers FT-20-24, 2000-lb capacity 35-hp lift truck highlight Catalog BU-485.

INSTRUMENT FOR ANALYSIS OF COMPLEX GAS MIXTURE. *Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.* A process control instrument for continuous measurement of the concentration of one gas in multi-component mixtures is described in Bulletin No. 0716-2. The bulletin describes the M-S-A Gas Thermatron and explains its selective measurement of one component in a complex sample stream through use of two different types of cells that have identical filaments.

SYNCHRONOUS MOTORS AND CONTROLS. *Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.* Booklet B-7292 is illustrated and contains motor selector charts, application data and formulas for calculating power factor. The booklet presents a quick summary of types and features of motors and controls. Material includes a discussion of power factor correction; factors to consider in selecting the motor and special application problems.

WIRE ROPE. *Macwhyte Wire Rope Co., Kenosha, Wis.* G-16 Blue Book of Wire Rope contains 190 pages of vital information. It answers such questions as—What is 6 by 19 Classification? Why and How Long Lay Is Different from Regular Lay? What is "Peening," "Rated Capacity," "Metallic Core," "Cable Laid Rope?" It covers such items as "Inspection," Correct Spooling," "Constructions," "Sheave Maintenance," "Multiple-Rope Reevings," "Swaged Fittings," and use and abuse of wire rope. The book is free to wire rope users.

MEDIUM PRESSURE HYDRAULIC HOSE ASSEMBLIES AND COUPLINGS. *Eastman Mfg. Co., Manitowoc, Wis.* Eastman Technical Bulletin 100 describes the company's medium pressure hydraulic hose and tube assemblies. The 36-page bulletin contains dimensional drawings and complete tables of available sizes.

ROTARY COMPRESSOR. *Sales Promotion Department, Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wis.* Bulletin P-121-B describes Le Roi's 365 rotary portable air compressor. Photographs are used to illustrate features of Model 365RD2, which the manufacturer claims to be the slowest running (1100 rpm)) 365 cfm on the market. The bulletin also includes general specifications.

(Continued on next page)

(Continued from preceding page)

GASOLINE ENGINES. *Hercules Motors Corp., 101-11th St., S. E., Canton, 2, Ohio.* Five completely revised two-page bulletins describing Hercules six-cylinder L-head gasoline engines—Bulletins E-116, E-118, E-137, E-139 and E-163—have been issued by Hercules Motors Corp. Each bulletin includes photos of the subject engine along with basic installation diagram, general data, power chart and detailed specifications. Engines covered in the five bulletins, in the order listed, include: Model RXC, 143 hp at 2400 rpm; Model HXE, 226 hp at 2000 rpm; model JXLD, 131 hp at 3200 rpm; Model QXLD, 91 hp at 3200 rpm, and Model WXLC-3, 139 hp at 2600 rpm.

RUBBER-METAL PRODUCTS. *Clevite Harris Products, Inc., Dept. A, Lockwood Road, Milan, Ohio.* Catalog covers rubber-metal products, including bearings, bushings, couplings, mounts, sleeves and molded shapes.

STORY OF FLUORESCENT MINERALS. *Ultra-Violet Products, Inc., San Gabriel, Calif.* The "Mineralights, Rocks and Rainbows" folder gives a "thumbnail review" of fluorescent mineral science and equipment. The eight-page booklet is available free to hobbyists, prospectors, collectors and educators.

WELDING. *All-State Welding Alloys Co., Inc., White Plains, N. Y.* A welding shop wall chart of 89 problem-solving, specialty alloys and fluxes sorts out the criteria which should be taken into consideration in choosing an alloy for welding shop application. The chart, 18 by 22 in. on heavy coated paper, covers maintenance, production and installation jobs.

EQUIPMENT FOR CRAWLER TRACTORS AND MOTOR GRADERS. *Construction Machinery Division, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. Catalog (M8-1189)* pictures and explains attachments and accessories Allis-Chalmers has available to increase the versatility and working capabilities of crawler tractors and motor graders, as well as add to operator comfort and safety under normal or unusual working conditions.

OXYGEN ANALYZER. *Beckman Scientific and Process Instruments Division, 2500 Fullerton Road, Fullerton, Calif.* Entitled "Major Cement Producer Gains Six Major Benefits Through Use of Beckman Oxygen Analyzer," Application Data Sheet O-4212 describes the system for cumbustion control on the rotary kilns which receive dry, ground, raw material.

CONTROL CABLE. *Chester Cable Corp., 257 Oakland Ave., Chester, N. Y.* A folder on plastic insulated and jacketed control cable (rated 600 volts) lists the specifications of small diameter-station-flexible and supervisory control cables with 2 to 19 conductors. Also IMSA municipal signal cables, Specifications 19 and 20—1956, with 3 to 12 conductors, are described.

AIR MOTOR. *Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.* Entitled "The Advantages of Air Motors," this bulletin, Form 5072A, features over 100 air motors in Ingersoll-Rand's line. These units cover a power range from 0.3 to 24 hp, with speeds running from 50 to 2580 rpm at rated horsepower. Both multi-vane and piston motors are listed with complete specifications and dimension drawings.

SHAFT-MOUNTED SPEED REDUCERS. *Link-Belt Co., Department PR, Prudential Plaza, Chicago 1, Ill.* Book 2618 contains engineering and selection information on: single reduction drives in six sizes, with nominal ratios of five to one and capacities up to 50 hp; and double reduction drives in seven sizes, with nominal ratios of 15 to one and up to 40 hp.

REAR DUMP. *Easton Car & Construction Co., Easton, Pa.* Bulletin 1-AS describes the Euclid-Easton S-12 Rear Dump 22-ton, variable wheel base).

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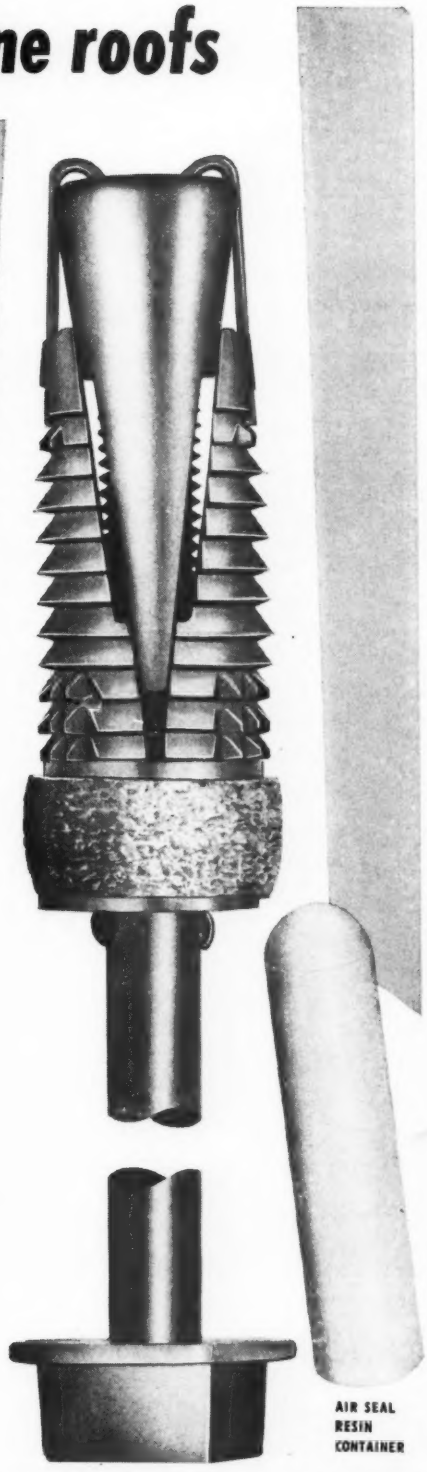

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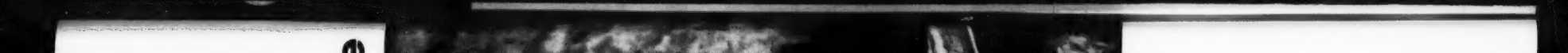
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